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THESIS

A METHODOLOGY FOR DETERMINING TRAINING EVENT COST

by

John Daniel Obal

June 1983

Thesis Advisor: Stephen J. Paek

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1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Methodology for Determining Training Event Cost		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis Jun 83
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John Daniel Obal		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE Jun 83
		13. NUMBER OF PAGES 139
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Training event cost
Linear Regression
Training Management and Control System
Battalion Training Management System
Resource Management

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis examines the two current Army methodologies, BTMS and TMACS, for planning and costing unit training events. In the process of examining the methodologies, this thesis reviews categories of training and the development of equipment operating cost factors. An additional training resource control scheme, the Jaehne model, is also presented. A model based on regression techniques is developed for determining the cost of battalion training events. Conclusions

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(Page 1) S/N 0102-014-6601

Item 20 (Contd)

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A Methodology for Determining Training Event Cost

by

John Daniel Obal
Captain, United States Army
B.A., University of Nebraska, 1974

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
June, 1983

Thesis
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TABLE OF CONTENTS

I. INTRODUCTION 12
A. THE COMMANDER'S CONCERN 12
B. INPUTS AND CONSIDERATIONS TO THE TRAINING PROGRAM 13
1. General 13
2. Department of the Army Directed Training Events 13
3. Higher Headquarters Directed Training . . 14
4. Unit Commander Determined Training 14
C. TRAINING MANAGEMENT 15
1. General 15
2. Long Range Plan 16
3. Short Term Plan 16
4. Near Term Plan 17
5. Resourcing 17
D. TRAINING MANAGEMENT CONTROL SYSTEM (TMACS) . . 18
1. Purpose 18
2. System Inputs and Considerations 19
E. TMACS INTERFACE WITH BTMS 21
1. Determining the Training Plan 21
2. Unconstrained Mode 21
3. Constrained Mode 21
4. Programming the Training Plan 22
5. Monitoring the Training Plan 22
F. COMMENTS AND OBSERVATIONS 22
G. SHORTFALLS IN TMACS 23
H. THE JAEHNE METHOD 23
I. SCOPE OF THESIS REPORT 26

II. THE GENERAL MODEL 28
A. GENERAL 28

B. FIRST ORDER MODEL 28
C. HIGHER ORDER MODELS 29
D. INTERACTION EFFECTS 30
E. MODEL BUILDING AND VARIABLE SELECTION 30
F. COMPUTER PACKAGES 31
G. RESULTS OF MULTIPLE REGRESSION 31
  1. Coefficients 31
  2. Coefficient of Multiple Determination . . 32
  3. Residuals 32
H. COMMENTS 33

III. MODEL DEVELOPMENT 34
A. GENERAL 34
B. THE RESPONSE VARIABLE 34
C. THE PREDICTOR VARIABLES 35
D. INITIAL ASSUMPTIONS 36

IV. DATA ANALYSIS 37
A. BACKGROUND 37
B. DATA RECONFIGURATION 38
C. COMMENTS AND OBSERVATIONS 38
D. SMOOTHING THE DATA 39
E. UNIT COMPARISONS 40
F. EVENT INFLUENCE 42
G. CYCLIC INFLUENCE 42
H. THE AUTOCORRELATION ISSUE 43
I. DATA LIMITATIONS 44
J. INDEPENDENT VARIABLE SELECTION 44

V. FITTING THE MODEL 45
A. GENERAL 45
B. FIRST BATTALION, FIRST BRIGADE 46
  1. Results 46
  2. Discussion 46
C. SECOND BATTALION, FIRST BRIGADE 47

1. Results 47
2. Discussion 48
D. THIRD BATTALION, FIRST BRIGADE 48
1. Results 48
2. Discussion 48
E. FIRST BATAIION, SECOND BRIGADE 50
1. Results 50
2. Discussion 50
F. SECOND BATTALION, SECOND BRIGADE 51
1. Results 51
2. Discussion 51
G. THIRD BATTALION, SECOND BRIGADE 52
1. Results 52
2. Discussion 52
H. COMMENTS AND OBSERVATIONS 53

VI. SUMMARY AND CONCLUSIONS 55
A. SUMMARY 55
B. CONCLUSIONS 56
C. IMPLEMENTATION 57
D. SYSTEM CONTROL 57
E. RECOMMENDATIONS FOR FUTURE STUDY 57

APPENDIX A: TRAINING EVENT CATEGORY ISSUE DEFINITIONS . 59

APPENDIX B: KEY TRAINING EVENTS OF FIRST BRIGADE UNITS . 65

APPENDIX C: KEY TRAINING EVENTS OF SECOND BRIGADE UNITS 67

APPENDIX D: UNIT COST PER DAY-TUFMIS REPORTED DATA . . . 69

APPENDIX E: DATA ANALYSIS FIGURES 72

APPENDIX F: UNIT COST PER DAY- SMOOTHED DATA 90

APPENDIX G: INFLUENTIAL TRAINING EVENTS 93

APPENDIX H: LAG K SAMPLE AUTOCORRELATION COEFFICIENTS . 95

APPENDIX I: COMPUTER LISTING FOR FIRST BN., FIRST BDE. . 96

APPENDIX J: COMPUTER LISTING FOR SECOND BN., FIRST BDE. 102

APPENDIX K: COMPUTER LISTING FOR THIRD BN., FIRST BDE. 110

APPENDIX L: COMPUTER LISTING FOR FIRST BN., SECOND BDE. 117

APPENDIX M: COMPUTER LISTING FOR SECOND BN., SECOND BDE. 125

APPENDIX N: COMPUTER LISTING FOR THIRD BN., SECOND BDE. 132

LIST OF REFERENCES 138

INITIAL DISTRIBUTION LIST 139

LIST OF TABLES

I. Smirnov Test Results 41
II. Median Test for Cycle Differences 43
III. Regression Summary-First Bn., First Bde. 46
IV. Regression Summary-Second Bn., First Bde. 47
V. Regression Summary-Third Bn., First Bde. 49
VI. Regression Summary-First Bn., Second Bde. 50
VII. Regression Summary-Second Bn., Second Bde. 51
VIII. Regression Summary-Third Bn., Second Bde. 52

LIST OF FIGURES

1.1 Unit Training Management Process 15
1.2 Long Range Plan 16
1.3 Short Range Plan 17
1.4 Near Term Plan 17
1.5 Resource Phase 18
1.6 Data Collection Worksheet 25
1.7 Completed Data Collection Worksheet 27
B.1 Major Training Events of First Battalion 65
B.2 Major Training Events of Second Battalion . . . 65
B.3 Major Training Events of Third Battalion 66
C.1 Major Training Events of First Battalion 67
C.2 Major Training Events of Second Battalion . . . 67
C.3 Major Training Events of Third Battalion 68
E.1 Daily Cost-First Bn., First Brigade 72
E.2 Daily Cost-Second Bn., First Brigade 73
E.3 Daily Cost-Third Bn., First Brigade 74
E.4 Daily Cost-First Bn., Second Brigade 75
E.5 Daily Cost-Second Bn., Second Brigade 76
E.6 Daily Cost-Third Bn., Second Brigade 77
E.7 Smoothed Cost-First Bn., First Brigade 78
E.8 Smoothed Cost-Second Bn., First Brigade 79
E.9 Smoothed Cost-Third Bn., First Brigade 80
E.10 Smoothed Cost-First Bn., Second Brigade 81
E.11 Smoothed Cost-Second Bn., Second Brigade 82
E.12 Smoothed Cost-Third Bn., Second Brigade 83
E.13 Rough Values-First Bn., First Brigade 84
E.14 Rough Values-Second Bn., First Brigade 85
E.15 Rough Values-Third Bn., First Brigade 86
E.16 Rough Values-First Bn., Second Brigade 87
E.17 Rough Values-Second Bn., Second Brigade 88

E.18 Rough Values-Third Bn., Second Brigade 89
G.1 First Brigade Influential Events 93
G.2 Second Brigade Influential Events 94

I. INTRODUCTION

A. THE COMMANDER'S CONCERN

The battalion commander in the Army of the 1980's is confronted with a myriad of necessary tasks. Training, maintenance, administration, readiness and other requirements vie for attention on a daily basis. Resource allocation and sound management are essential to maintaining a combat ready battalion.

> "From the Army's viewpoint, the basic management concept is to assign a commander a mission, provide him with the necessary resources to carry out this mission, and hold him accountable for the judicious use of these resources and the proper execution of this mission...assignment, planning and direction of missions must be integrated with resources consumed to achieve sound management practices." [Ref. 1]

Provision for and consumption of resources, however, does not define the total realm of the commander's responsibility. The commander must also project the resources required for the mission and compete for their allocation in an austere environment. Limited availability of time, fuel, manpower, facilities, and dollars requires sound planning, programming, and utilization of resources.

> "If we hope to be ready, we must justify our resource needs(plan), successfully compete for allocation of these resources(program and budget) and account for the public trust expressed in these allocations." [Ref. 2: p.3]

The force that drives resource requirements is the unit training program. The training program delineates unit activities for a defined period of time and is, in essence, the commander's "performance contract". Formulating,

resourcing and conducting this program is clearly the commander's concern. Present day systems exist to aid the commander in developing and executing this program.

The remainder of this chapter will discuss the inputs and considerations in developing the training program. The two current Army methodologies for planning, programming, and resourcing unit requirements, the Batalion Training Management System (BTMS) and the Training Management and Control System (TMACS), will be examined. An additional scheme, the Jaehne Model, will also be presented. Shortcomings of these methods will be noted and an alternative technique will be proposed.

B. INPUTS AND CONSIDERATIONS TO THE TRAINING PROGRAM

1. General

The basic subunit of the training program is the training event. The training program itself is merely the carrier in which the training events, and the actions necessary to support them, are scheduled. The events of the program can be classified as follows:

a. Directed by Department of the Army
b. Directed by Higher Headquarters
c. Determined as necessary by the Battalion Commander

2. Department of the Army Directed Training Events

The Department of the Army directed events were established to provide a measure of standardization for training in Army units, as well as establishing criteria for identifying deficiencies in unit readiness. Published guidelines prescribe the frequency and level of unit participation for each event. Measures of performance are provided to determine the actual readiness posture of the

unit. Additionally, Department of the Army tasks units to conduct activities peculiar to the Army mission in support of the Department of Defense and Joint Service missions.

Some of the mandatory events are:

a. Readiness training of Individuals, Crews, Units-Standards for all Army units
b. Readiness training of Individuals, Crews, Units-Standards for specific battalions
c. Joint Training Exercises-REFORGER, Brave Shield, etc.
d. Special Training-Jungle Warfare School, Arctic Warfare School, etc.
e. Support to National Guard and Reserve Components

3. Higher Headquarters Directed Training

These events consist of requirements generated at Corps, Division, and/or Brigade level required by local missions and conditions. These mandatory events include, but are not limited to:

a. Field Training Exercises (FTX)
b. Command Post Exercises (CPX)
c. Special Training (local peculiar)-Amphibious landing training, etc.
d. Post Support Activities
e. Community Relations Activities

4. Unit Commander Determined Training

As the commander evaluates the proficiency of his unit, deficient areas and requirements to sustain proficiency are identified. Based on his perceptions of unit status, the following mandatory events may be listed:

a. Individual soldier proficiency training
b. Unit proficiency training

C. TRAINING MANAGEMENT

1. General

Management of the multi-echelon requirements is a continuous process as depicted in Fig. 1.1 [Ref. 3: p. 1-12].

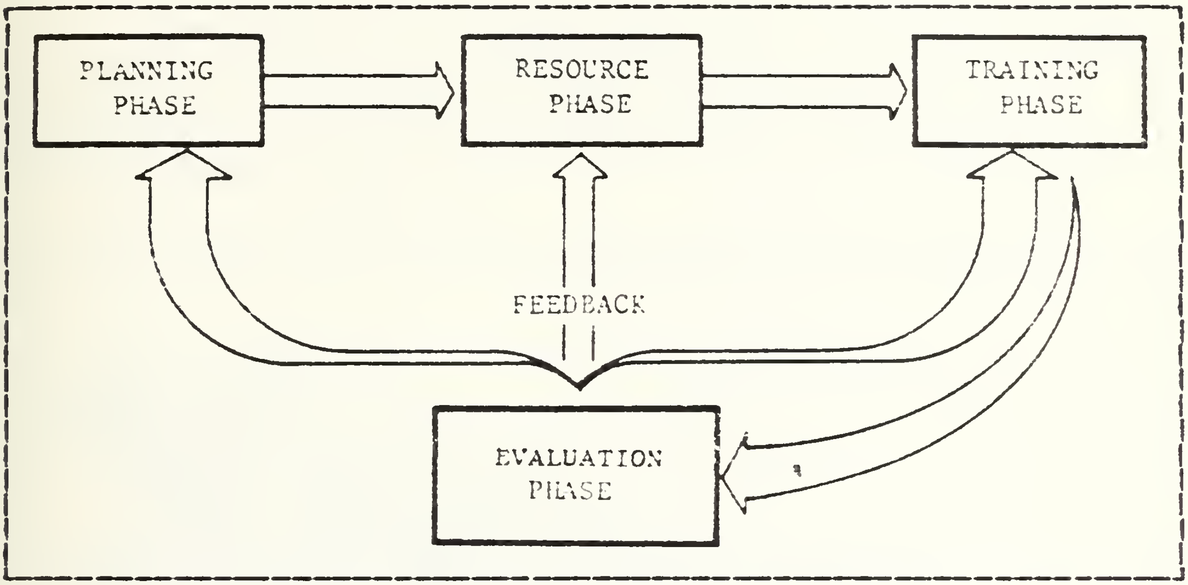


Figure 1.1 Unit Training Management Process.

The Department of the Army has initiated a program that standardizes training management methodology. This is the Battalion Training Management System (BTMS).

The Battalion Training Management System (BTMS) was implemented in 1975 to provide standard guidelines for formulating tasks associated with the planning, preparation, conduct, evaluation and reporting of unit training. BTMS stresses logical, sequential planning and coordination of training activities. This allows each of the various levels of requirements to be thoroughly developed and coordinated throughout the course of the training period.

The training program consists of three planning and programming decision periods. These are: the long range, the short range and the near term plans. In succeeding sections, the roles and interdependencies of the plans will be highlighted.

2. Long Range Plan

The battalion's long range plan is broad in scope and provides a general direction to the unit program. The products and actions of the long range plan are given in Fig. 1.2 [Ref. 3: p. 1-14].

- -Mission list
- -Mission priorities
- -Unit goals
- -Estimate of status
    - -Determine unit status
    - -Analyze performance
    - -Assess training environment
- -Training priorities
- -Projected requirements and training events
- -12 to 24 month planning calendar
- -General guidance

Figure 1.2 Long Range Plan.

Changes to the long range plan are made as the short and near term plans are updated.

3. Short Term Plan

Short range planning converts the long-range training program into a series of training activities and gives detailed guidance to subordinate units on the conduct of the training. The actions and products of the short range plan are given in Fig. 1.3 [Ref. 3: p. 1-14].

-Training Program review
-Update of current unit status
-3 to 4 month planning calendar
-Specific training objective and guidance
-Appropriate training methods
-Assigned responsibilities

Figure 1.3 Short Range Plan.

4. Near Term Plan

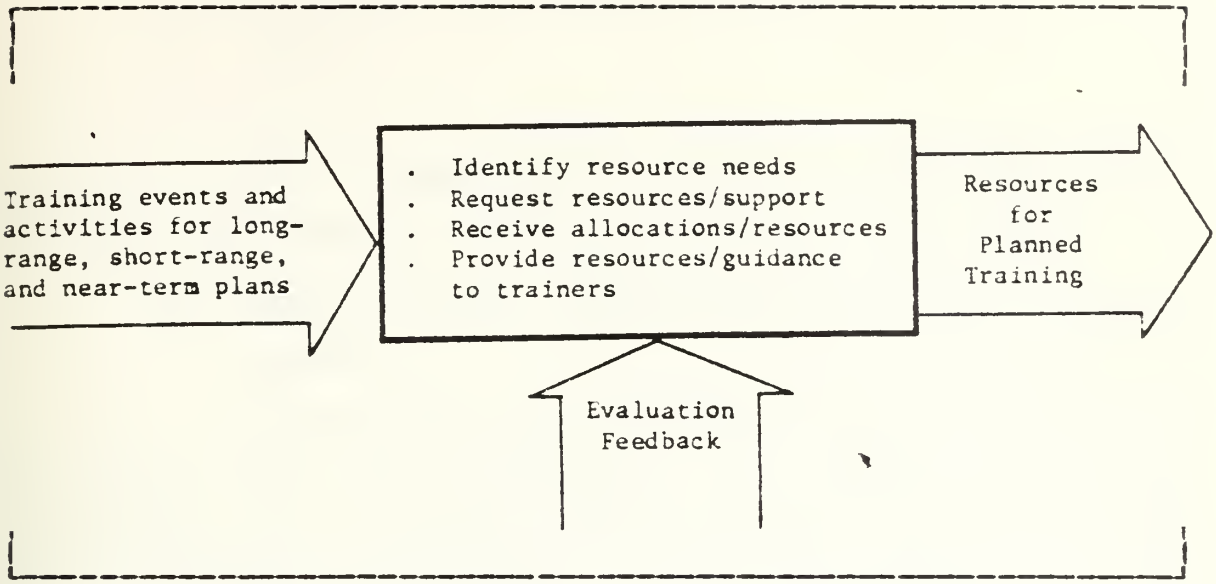
Near term planning provides the detailed schedules that control and coordinate unit daily activities, and gives specific guidance to personnel involved in the training process. Fig. 1.4 gives the products and actions of the near term plan [Ref. 3: p.1-14].

-Review of short range guidance and training objectives
-Review of ongoing training
   -3 to 6 weeks ahead for Active Component
   -3 months ahead for Reserve Component
-Qualified trainers/evaluators

Figure 1.4 Near Term Plan.

5. Resourcing

The long range, short range, and near term plans identify events and activities that require resources and support. The resource process is based on the events and activities identified in the planning stages. Fig. 1.5 shows the actions and results of the resource phase [Ref. 3: p. 1-16].



Training events and activities for long-range, short-range, and near-term plans
. Identify resource needs
. Request resources/support
. Receive allocations/resources
. Provide resources/guidance to trainers
Resources for Planned Training
Evaluation Feedback

Figure 1.5 Resource Phase.

The Training Management Control System (TMACS) is a resource planning tool available to assist the commander and his staff in developing training plans that can be conducted within resource levels. The following sections will provide a general overview of TMACS and its' interface with BTMS.

D. TRAINING MANAGEMENT CONTROL SYSTEM (TMACS)

1. Purpose

The Training Management Control System (TMACS) provides a simple, interactive training resource planning and programming capability for battalion, brigade and division commanders.

2. System Inputs and Considerations

a. General

Prior to a general description of how IMACS operates and its' interface with BTMS, the development of the input data base and terminology will be discussed.

b. Common Costing Methodology for Unit Training (CCMUT)

CCMUT delineates the method by which Army units determine costs of training. It provides standard definitions of training and factors for capturing weapons/equipment usage costs.

Training is defined in terms of Battalion Days (BD), and Battalion Training Days (BTD). A Battalion Day is a calendar day or portion thereof (measured in increments of 1/2) during which a battalion or battalion equivalent is engaged in a defined activity. A Battalion Training Day is defined as a battalion day of activity planned or accomplished for the primary purpose of training. A Battalion Equivalent is a factor assigned to units smaller than a battalion.

Battalion days are accounted for by assignment of a Training Event Category Code (TECC). TECC's are those training activities approved by all Major Commands to provide commonality in budgetary considerations by event. Definitions of TECC's are provided in Appendix A.

c. Cost Factor Development

(1) Recognizing the need to determine unit training costs, the Army has adopted a data collection methodology to provide mileage/usage cost factors and cost of repair parts and fuel.

(2) The Tactical Unit Financial Management Information System (TUFMIS) automatically details dollar commitments for repair parts for each Weapon Equipment System Designator Code (WESDC) by battalion on a monthly basis. In addition, the unit manually collects and reports WESDC operational data (fuel consumed, miles driven, hours operated, etc.)

(3) When this data collection plan was initiated, operational figures were collected on all WESDC's by all units. The requirement for data collection and recording became a significant time burden. To lessen this task, the concept of the cost driver was implemented. Cost drivers are those WESDC's that collectively account for 95% of total fuel and repair parts consumed at the installation level. As an alternative to collecting data from the whole population, sampling techniques may be used to derive the operational inputs of the cost drivers. Sampling will free maneuver units from collecting data all equipment.

> "We feel the workload savings to be derived from sampling will more than offset the potential loss of precision and should provide results which are reasonable and sufficient for management purposes." [Ref. 4: p.5]

(4) When the TUFMIS data and operating figures are collected, they are aggregated at the installation level and by a simple averaging process, the following cost factors are calculated:

a. Cost of fuel per mile/hour of operation

b. Cost of organizational repair parts per mile/hour of operation

c. Cost of organizational repair parts per gallon of fuel consumed

d. Miles/hours operated per gallon of fuel

The data base is updated semiannually and revised factors are published [Ref. 4].

E. TMACS INTERFACE WITH BTMS

1. Determining the Training Plan

As previously mentioned, the planning process develops the training events necessary to support the missions and goals of the unit. For input to TMACS, these events are classified as optional or required, prioritized and quantified. The quantification consists of determining the size and type of unit, as well as the utilization estimates for each vehicle/weapons system required for the event. This input, coupled with the CCMUT definitions and the cost factors in the system data base, allows TMACS to compute resource requirements. A linear programming model is the basis for optimization of the training program as a function of the priorities determined by the commander.

2. Unconstrained Mode

Based on the commander's priorities, TMACS lists the initial training program in an unlimited resource environment. This mode calculates the number of BD/BTD required and provides a total cost figure by event. All events are categorized as "CAN BE CONDUCTED".

3. Constrained Mode

After calculating the total program cost, assigned resource levels are entered. The linear program optimizes the training program subject to resource constraints. The ouput of the program consists of those projected events which can be conducted within resource constraints and those which cannot be met. The total resource requirements for the "CAN BE CONDUCTED" and the "CANNOT BE CONDUCTED" events

are also provided. The commander may then perform interactive analysis by changing priorities, events, and unit participation level to arrive at possible alternatives to the initial optimal event mix.

4. Programming the Training Plan

Once the training strategy has been developed, a long range planning calendar is finalized and guidance provided to the subordinate units to help prepare short range plans. The units translate the program into a practical series of training events, arrange for, and allocate resources needed for the training.

5. Monitoring the Training Plan

As events of the short term period are conducted, the actual training costs incurred are entered into TMACS. The cost figures are used to update the data base,and replace the cost estimates for that event previously calculated by TMACS.

The optimization process should be redone at least quarterly to account for actual expenditures and changes in the training program. This recalculation process may cause transition of events from the "CAN BE CONDUCTED" to the "CANNOT BE CONDUCTED" category (and vice versa). The impact of events dropped from the program can quickly be assessed and, if necessary, justification documents for additional resources can be generated.

F. COMMENTS AND OBSERVATIONS

BTMS and TMACS are complementary processes that provide a powerful management tool to the commander. However, the data recording requirement may place a burden on units with a large number of weapon systems and/or training events.

G. SHORTFALLS IN TMACS

Although TMACS provides reasonable predictive and monitoring capability, it has shortfalls and deficiencies as follows:

1. Data collection requirements may become a burden on the unit.
2. TMACS requires operator training/expertise to employ.
3. System usage appears minimal. Peak demand for service coincides with major budgetary milestones [Ref. 5: p. 58].
4. TMACS is oriented toward funds control as opposed to management or training control [Ref. 7: p. 72].
5. TMACS does not compare available total time against the desired total time [Ref. 7: p. 72].

H. THE JAEHNE METHOD

Jaehne [Ref. 5] presented an alternative methodology to TMACS and proposed a battalion level system that would provide the commander with an internal cost control and monitoring capability. Concern for deficiencies as noted by Brown [Ref. 6] and Mitchell [Ref. 7] prompted his examination of the financial control structure of Army units. Brown [Ref. 6: p. 79] felt the dependency of TMACS on cost factor input would produce questionable event costs. Additionally, the inability of TMACS to derive indirect costs associated with training was highlighted. Mitchell [Ref. 7: p. 72] felt that TMACS did not optimize training by providing the best mix of training events but rather optimized a manually picked training sequence constrained by budget, training areas, and field training time. He also felt that TMACS was not a training control system but a funds control system.

Jaehne's system was based on capturing costs at the battalion level and correlating them to the training events conducted. The data to support this method was gathered on the resource data collection sheet, Fig. 1.6. Each day in the collection period was identified as a Non-training day (weekend, holiday) or as a Major Activity day (range fire, FTX, etc.). All other days were Garrison Training days. Additionally, the battalion equivalent participating in a major activity was noted.

The costs incurred for fuel, repair parts, other supplies, and ammunition consumed during each week was also recorded. Fig. 1.7 provides an example of a completed data sheet to support the model.

Based on the data collected, the commander is able to identify the fixed operating costs and the marginal costs for each type of training event. Plots of weekly costs could easily be generated to provide gross costing figures for "rule of thumb" analysis of expenditure trends.

To validate the feasibility of this method, data on the expenditures of two light infantry battalions of the Seventh Infantry Division, Fort Ord, California, was collected for a ninety day period. Although the time period was short and the sample size small, the following observations could be made about the results:

1. Historical data is effective in relating expenditures to training events conducted.
2. Data collection and maintenance of cost figures on a continuing basis was critical to method effectiveness.
3. The time and human resources necessary to operate this system were minimal.

Jaehne concluded [Ref. 5: p. 135],

> "The proposed internal control system for battalions ... illustrated that historical unit cost data could be

MAJOR TRAINING ACTIVITY CALENDAR

UNIT____________________ WEEK OF__________________

S	M	T	W	T	F	S

N: Non Training Day

UNIT	FUEL (M/G gal)	CL IX ($)	AMMO (*)	OTHER ($)

* A Battalion/Division Munition Code

Figure 1.6 Data Collection Worksheet.

> collected and retained with minimal impact on battalion operations. It is capable of separating fixed, variable, and non-training day costs..."

I. SCOPE OF THESIS REPORT

This thesis focuses on developing a mathematical model which employs an expanded historical data base to identify the factors capable of predicting resource consumption at the battalion level. This model will attempt to define a "middle ground" between BTMS/TMACS and the Jaehne methodologies, as well as provide the commander with a simple to operate, flexible tool for determining event costs. Although the other systems are capable of considering multiple resource types, this report will concentrate on fiscal expenditures only.

In succeeding chapters, an examination of the general characteristics of the mathematical model will be discussed with an extension toward fiscal management and control. Following the description, a demonstration of the model's applicability will be shown on an existing historical data base. The results are then reviewed to determine model efficiency and utility. Finally, conclusions and recommendations are provided. This thesis attempts to isolate key factors in fiscal expenditures and develop a model adequate in describing the influences of these factors.

MAJOR TRAINING ACTIVITY CALENDAR

UNIT 1-1 Inf WEEK OF 1 Sep- 12 Oct 8x

	S	M	T	W	T	F	S
1-7	------ DIV	FTX ------	------------				N
8-14	N		(1,4) -- M16 ---- Qual				N
15-21	N						N
22-28	N						N
29-5	N	------------	--- (1,4)	ARTEP ----	------------		N
6-12	N					N	N

N: Non Training Day

	UNIT	FUEL (M/D gal)		CL IX ($)	AMMO (*)	OTHER ($)
1-7	1-1 Inf	304	490	1334	4k-B, 5-F 12k-D, 8-E	668
8-14	"	20	40	1592	1260-A 3400-C	561
15-21	"	50	0	1791	0	700
22-28	"	40	35	327	0	2744
29-5	"	200	125	1400	10000-A 2000-C	243
6-12	"	45	90	1052	0	1250

* A Battalion/Division Munition Code

Figure 1.7 Completed Data Collection Worksheet.

II. THE GENERAL MODEL

A. GENERAL

The mathematical model developed to predict training event cost is based on multiple linear regression techniques. The model presumes the existence of "predictor" variables which affect the observed quantity of interest. The "predictors" will be referred to as the independent variables.

B. FIRST ORDER MODEL

In the case of n-1 independent variables, x1,x2,...x(n-1), the multiple linear regression model takes the following form:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} \ldots + \beta_{n-1} X_{i,n-1} + \varepsilon_i \qquad (2.1)$$

where:

Y_i is the response of the ith observation

$\beta_0, \beta_1, \ldots \beta_{n-1}$ are the regression coefficients of the independent variables

$X_{i1}, X_{i2}, \ldots X_{i,n-1}$ are the independent variables (known constants) of the ith observation

ε_i is the residual term of the ith observation

$i=1,2,3,\ldots t$ indicate individual observations

Alternatively, if x_{i0} is defined to be 1, the model becomes:

$$Y_i = \sum_{k=0}^{n-1} \beta_k X_{ik} + \varepsilon_i \tag{2.2}$$

The expected value, E(Y), of Eqn. 2.1 becomes:

$$E(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_{n-1} X_{n-1} \tag{2.3}$$

since $E(\varepsilon_i) = 0$.

The model depicted in Eqn. 2.1 is a first order model with no interaction between independent variables.

C. HIGHER ORDER MODELS

If the effects of the independent variable, X , is not linear, but appears curvilinear, it may be better expressed by a power, e.g. X^2, X^3, etc. For example, a regression model of one independent variable, X_1 , of the form:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_{11} X^2_{i1} + \varepsilon_i \tag{2.4}$$

is classified as a second order model because of the quadratic term X_i^2. Models of higher order are denoted in similar manner, with the order of the model equal to the maximum value of the exponent of the independent variable.

D. INTERACTION EFFECTS

The response variable under consideration may also be influenced by the interaction of the independent variables. As an example of a model with interaction effects, a second order model with two independent varables, X_1, X_2, can be expressed as:

$$Y = \beta_0+\beta_1X_1 +\beta_2X_2+\beta_{11}X_1 +\beta_{22}X_2 +\beta_{12}X_1X_2 + \varepsilon \qquad (2.5)$$

The presence of the cross-product term, X_1X_2 , indicates the interaction of the variables. The possible presence of interaction requires additional specification of the cross-products of the variables.

E. MODEL BUILDING AND VARIABLE SELECTION

1. As a first step in the model building process, all variables pertinent to the problem should be identified. It is important to note that the initial list should be as comprehensive as possible. Admittedly, this list will be large but subsequent assessment techniques will reduce it to a more reasonable size. The comprehensive listing will contain variables that:

   a. May not be fundamental to the problem.
   b. May be subject to measurement errors.
   c. May effectively duplicate another independent variable in the list.

Other independent variables which cannot be measured may be deleted or replaced by proxy variables which are highly correlated with them [Ref. 8: p.372]. Additional examination of the variable list may suggest inclusion of interaction terms, quadratic terms, etc., to the general model specification.

2. The list of variables must be kept to a minimum for a variety of reasons. Regression models with a large number of independent variables are:

   a. Difficult to analyze
   b. Expensive to maintain
   c. Induce measurement errors

3. The most common variable selection techniques are:

   a. All possible regressions method
   b. Stepwise regression method
   c. t-directed search

Summaries of these methods may be found in linear regression texts. [Ref. 9]

F. COMPUTER PACKAGES

Many computer packages contain regression subroutines of various detail and complexity. The regression calculations of this report will employ the MINITAB package.

G. RESULTS OF MULTIPLE REGRESSION

1. Coefficients

The coefficients (β_1, β_2, etc.) determined through regression are those estimators that minimize the value:

$$Q = \sum_{i=1}^{t} (Y_i - (\beta_0+\beta_1 X_{i1}+\ldots)\ )^2 \qquad (2.6)$$

This is the method of least squares. The estimators are unbiased and are the most efficient linear estimators.

2. Coefficient of Multiple Determination

The coefficient of multiple determination, denoted by R^2, measures the percentage of the variation of the dependent variable that is explained by the set of independent variables in the model. This value ranges from 0 to 1. A model that perfectly represents the data would have a coefficient of 1.

3. Residuals

The residual terms that are provided after model fitting are indicators of the suitability of the model. Residuals are defined as follows:

$$\varepsilon_i = Y_i - \widehat{Y}_i \qquad (2.7)$$

where:

Y_i is the ith observation

$\widehat{Y}_i$ is the predicted value for the ith observation

Residual analysis is conducted by graphical techniques to indicate violations of the basic assumptions or the omission of higher order or interaction terms. This technique is useful in modifying the basic model.

H. COMMENTS

This chapter provides a quick overview of the principles of linear regression and model forms. Extensive studies of regression have been done and many textbooks are available on the subject.

In the following chapters, the principles of the linear model will be applied toward development of a technique to identify key influences in training event cost and to provide a predictive capability to the commander.

III. MODEL DEVELOPMENT

A. GENERAL

As noted in the previous chapter, regression techniques are especially applicable in developing predictive models. In estimating training event cost, it is obvious that there are many variables that may have an effect on the resources required.

This chapter will address the problem of identifying the possible factors influencing the cost. These factors, by design, should be readily measureable and significant in providing an adequate estimate.

B. THE RESPONSE VARIABLE

Many of the resources considered in conducting an event are utilized only during the execution of training. Personnel, training areas and time are examples of this type of resource. Dollars, on the other hand, are committed for a specific event in periods other than when the resources are required. A major field exercise causes demands for spare parts and supplies for several weeks prior to and several weeks after the actual training is conducted. The model to be developed will use dollar expenditures as the response variable, denoted as Y . For reasons to be addressed in following chapters, the unit of measurement will be dollars per day.

C. THE PREDICTOR VARIABLES

1. With the response variable identified, the explanatory variables to which the model will be fit can be selected. The selection of variables is based on operational experience and data availability at the unit level.

Some of the variables which could have an effect on event cost include, but are not limited to, the following:

a. Unit effect-Influence attributable to guidance and priorities of the commander.

b. Cycle effect-Influence attributable to alternating training and support cycles.

c. Event effect-Influence that the nature of the event carries, to include lead/lag characteristics.

d. Fiscal quarter effect-Influence attributable to quarter of the fiscal year.

e. Environmental effect-Influence attributable to geographic location of post/training facility.

f. Organizational effect-Influence attributable to level of mechanization/ technology in the unit.

g. Force activity effect-Influence attributable to Department of the Army imposed readiness posture.

Effects a-d are easily measured at the unit level while effects e-g may be impossible to quantify.

This listing is by no means all encompassing. Levels of data availability and other location peculiar factors may also be considered.

2. As may be evident by consideration of some of the variables listed above, a qualitative rather than quantitative measure may be necessary. Quantitative variables take on values well defined by scale (speed, width, weight, etc.). Qualitative variables, on the other hand, are indicative in nature (male/ female, on/off, etc.).

For regression calculations, qualitative variables are treated in the same manner as quantitative. As one of the goals of the model is to reduce the data collection necessary to produce cost estimates, the presence of qualitative variables is highly desireable. Most qualitative variables take the value 0 or 1, indicating the absence or presence of a factor.

3. The effect of leading/lagging expenditures must also be considered in any listing of possible factors. Because of the inherent delays in the logistics system, supplies and spare parts required for an event must be requisitioned several time periods prior to anticipated use. Moreover, equipment utilization generates additional demands that may not be processed for several time periods after event completion. It is obvious that the type and duration of the event would affect the lead/lag span of demands.

D. INITIAL ASSUMPTIONS

For preliminary model fitting, the following assumptions are made:

1. Effects of the independent variables are additive.
2. There is no interaction between variables.

In the following chapter, an existing historical data base will be examined and analytical techniques will be employed to identify the key factors in training event cost.

IV. DATA ANALYSIS

A. BACKGROUND

Identification of independent variables capable of predicting training event cost can best be accomplished through analysis of historical data. To this end, a listing of the expenditures in support of the Fiscal Year 1982 Annual Training Program of the Seventh Infantry Division, Fort Ord, California, was acquired. The expenditure reports are provided on a recurring basis through the TUFMIS reporting system, detailing the general supplies and repair parts commitments by battalion.

Only a portion of the Divisional units were examined; namely, the six maneuver battalions of the First and Second Infantry Brigades.

The training events that were considered were extracted from the Division Master Training Schedule. This schedule divided the training period into 51 7-day training weeks (Sunday through Saturday). Two partial weeks were also included; specifically, the period 1 to 3 October (carry-over from FY-81) and the period 26-30 September (lead in to FY-83). The figures derived for the partial weeks were included in the analysis.

The master schedule sets forth the time periods for major events. Higher headquarters directed training is reflected at division level. At the battalion level, only major events and support missions are listed. These events include:

1. Field Training Exercises
2. The Army Training and Evaluation Program (ARTEP)
3. Joint Readiness Exercises

4. Special training exercises (Jungle operations school, amphibious landing school)

5. Guard/Funeral detail

6. Support to National Guard and Reserve Component Annual Training

7. Reaction Force

The major training events for First and Second Brigade are listed in Appendix B and Appendix C, respectively.

In the remainder of the chapter, the results of the data analysis will be reported and an initial listing of key influence factors will be provided.

B. DATA RECONFIGURATION

The frequency of TUFMIS reports detailing fiscal commitments did not correspond to the training week structure of the Master Schedule. In the course of the year, fifty reports were issued, with the time period between reports ranging from two to thirteen days. To relate period expenditures to events conducted, the data was reconfigured to align it with the training program.

As a first step, the TUFMIS based average daily cost was calculated by dividing total period commitments by period length. These figures were used to assign a cost to each day of the year, from which the training week average daily cost was derived. The cost figures derived for each training week for each battalion are listed in Appendix D.

C. COMMENTS AND OBSERVATIONS

Because of the low resolution view of the training that the Master Schedule provided, it was impossible to determine whether, in fact, training had been conducted on a non-training day (Saturday, Sunday, holiday). Additionally, the designation of major events in week long increments did

not allow for identification of preparation days (as a deployment exercise might contain) or any other deviation from the set time period.

When the data structure is viewed in relation to BTMS/TMCS, the concept of BD/BTD and Battalion Equivalents is disregarded due to the nature of the schedule.

D. SMOOTHING THE DATA

The cost figures derived in Section B were plotted against the training week. Plots are listed in Appendix E. The plots were examined to determine the existence of a general expenditure pattern. Cost increases appear regularly with abrupt changes in magnitude, but a clear indication of the correlation of daily cost to training event was not discernable. In order to get a clearer view of the data, a smoothing process was employed.

The purpose of smoothing is to find a general pattern in the data, free of detail. Because of the possibility of influential outlier values, a method of smoothing should be used that retains the shape of the data, yet does not eliminate certain points, as a typical data trimming procedure might. For this reason, a single application of Tukey's method of running medians of three with end point rule was done [Ref. 10: p.210]. This gives a better view of the "big picture" and eliminates the effect of outliers. Daily costs after smoothing are listed in Appendix F. Plots of the smoothed values versus the training week are given in Appendix E. The difference between the plots of the smooth and raw data is clearly evident when plots from the same unit are compared. The trend of the smooth data is discernable and periods of increased expenditures can easily be identified.

As in regression, the residuals derived from the smoothing process must be examined. The equivalent error term is known as the "rough", with the general relation written as:

$$\text{DATA} = \text{SMOOTH} + \text{ROUGH} \qquad (4.1)$$

The roughs were plotted against the training week as listed in Appendix E. They appear to have median value around zero but demonstrate heteroscedacity and some time dependency.

The smoothing process removes the influence of outliers not explainable by the training schedule yet does not significantly change the general nature of the data. The smoothed data would be preferable to use for the remainder of the analysis.

The Smirnov test was conducted to determine if the distributions of the raw and smoothed data are the same. Formally:

> Null Hypothesis:The distribution of the smoothed data is the same as the distribution of the raw data.
>
> Alternative Hypothesis: The distributions are not the same.

Test summary listed in Table I.

Smoothed values will be used throughout the remainder of the analysis.

E. UNIT COMPARISONS

As previously indicated, the priorities, goals and objectives of the commander may be a factor in event cost. To examine the possibility of differences between brigades,

TABLE I

Smirnov Test Results

UNIT	TEST STATISTIC	CRITICAL LEVEL	NONREJECT/REJECT NULL HYPOTHESIS
First Bde.			
1st Bn.	.132	>.2	Nonreject
2nd Bn.	.113	>.2	Nonreject
3rd Bn.	.132	>.2	Nonreject
Second Bde.			
1st Bn.	.132	>.2	Nonreject
2nd Bn.	.113	>.2	Nonreject
3rd Bn.	.075	>.2	Nonreject

the median test was performed. The median was chosen due to its' robust indication of centrality and resistance to any outliers remaining after smoothing. Formally:

> Null Hypothesis: The medians of the First and Second Brigade are the same.
>
> Alternative Hypothesis: The medians of the Brigades are different.

The test statistic provided by this procedure yielded a critical level in excess of .25. Thus, the null hypothesis is not rejected.

Comparison of the median daily costs in each of the battalions was also considered. The hypotheses tested are:

> Null Hypothesis: The medians of all battalions are the same.
>
> Alternative Hypothesis: At least two battalions have different medians.

The test statistic derived yielded a critical level of .2; thus, the null hypothesis is not rejected.

F. EVENT INFLUENCE

In order to identify the events that caused significant changes in daily cost, the data for each unit was sorted. The indices of the training weeks provided showed the relationship of events to high and low average daily costs. The high and low cost events for each unit are listed in Appendix G.

ARTEPs and field training exercises appear to be the major causes of cost variance. This is intuitively plausible based on the fact that units prepare for these events for weeks in advance. While on the event; however, many of the routine tasks causing expenditures in the garrison environment are delayed until the unit returns from the exercise. The effect is not consistent, however, in:

1. Effect of lead/lag committments-In some units, lead/lag causes high cost, while other units' lead/lag indicates low cost.
2. Length of lead/lag period-Span of lead/lag commitments is not standard across units.

Additionally, it appears the start and end of a fiscal quarter has some effect. This seems realistic, considering the phenomena associated with end of year spending.

It is evident that major events do exert influence on the surrounding weeks. As noted, however, it appears that the strongest influence exists for a period about 4 weeks before through 4 weeks after the event, with the period of event execution not included in the span.

G. CYCLIC INFLUENCE

A fundamental difference may exist in expenditures based on the alternating training and support cycles. The median test was also conducted on the expenditures of support and training weeks.

Formally, the test is denoted:

> Null Hypothesis: The median of the support cycle expenditures is the same as the median of the training cycles.
>
> Alternative Hypothesis: The medians of the support and training cycles are different.

Summary of the results is provided in Table II.

TABLE II

Median Test for Cycle Differences

UNIT	CRITICAL LEVEL	NONREJECT/REJECT NULL HYPOTHESIS
First Brigade		
1st Bn.	>.25	Nonreject
2nd Bn.	>.1	Nonreject
3rd Bn.	>.25	Nonreject
Second Brigade		
1st Bn.	>.25	Nonreject
2nd Bn.	>.25	Nonreject
3rd Bn.	>.25	Nonreject

Based on the information provided by the tests, there is no difference between the medians of the training and support cycles.

H. THE AUTOCORRELATION ISSUE

The lead/lag span issue suggests the presence of autocorrelation in the data. The lag k correlation coefficients for each unit were calculated and the results listed in Appendix H.

Examination of the coefficients show positive correlation at lags 1 through 4 weeks. The presence of negative correlation at lags 10 or greater may imply a "seasonal effect"; however, it may be attributable to mere happenstance.

I. DATA LIMITATIONS

The candidates for independent variables are limited in part by the low resolution of the data and the master training schedule. The variables examined to this point have been those inferred by comparing average daily costs to events conducted.

Possible additional variables that may be considered are the Battalion Training Days per week (as suggested by Jaehne), number of cost drivers utilized in each event, etc. These variables may be derived through detailed data collection or extracted from after-action reports.

Additionally, as this is a battalion level model, company activities are not included in the master training schedule. The influences exerted by company events could be expected to be similar to those of battalion events.

J. INDEPENDENT VARIABLE SELECTION

Based on the analysis of available data and the inferences drawn from it, the following variables will be included in the initial regression model:

1. Quantitative Variables
    - Lag 1 through Lag 6 expenditures
2. Qualitative Variables
    - Conducting an event
    - Four week period prior to an event
    - Four week period after an event

The next chapter will address fitting and modification of the model.

V. FITTING THE MODEL

A. GENERAL

1. This chapter describes the results of fitting the identified independent variables to the daily expenditure data. As noted earlier, the primary goal in the model development will be to arrive at a simple to use predictive equation that requires minimal data collection and personnel expertise.

2. The independent variables that will be considered for initial model inclusion are:

   a. Quantitative

      -Lag 1 Cost

      -Lag 2 Cost

      -Lag 3 Cost

      -Lag 4 Cost

      -Lag 5 Cost

      -Lag 6 Cost

   b. Qualitative

      -Four weeks before major event(Pre-Ex)

      -Four weeks after a major event(Post-Ex)

      -Conducting a major event(On-Ex)

During the fitting process, additional variables may be suggested, as well as interaction and/or higher order terms.

3. The fitting effort will begin by regression on on all independent variables, followed by variable selection by stepwise regression, with modification of variables as necessary.

4. Through each step of the process, examination of residual terms will be a major concern. Many of the modifications will be based on the indications given when

the residuals are plotted against time. Configuration of the plots may suggest violations of the basic model assumptions or inclusion of additional variables.

5. All calculations done in this chapter were accomplished through the MINITAB package [Ref. 11].

6. In the following sections, the model results for each battalion will be provided.

B. FIRST BATTALION, FIRST BRIGADE

1. Results

Summary of the results listed in Table III.

TABLE III

Regression Summary-First Bn., First Bde.

ACTION	VARIABLES IN MODEL	R^2	R^2 ADJUSTED
Regression on all variables	Lag 1-Lag 6, On Ex, Pre-Ex, Post-Ex	66.2	57.7
Stepwise regression	Lag 1, Lag 2, On-Ex, Post-Ex	61.36	-
Regression on selected variables	Lag 1, Lag 2, On-Ex, Post-Ex	63.0	59.7
Modification-Add Fourth Quarter Effect	Lag 1, Lag 2, On-Ex Post-Ex, Fourth	66.1	62.3

2. Discussion

Examination of the plot of residuals when all variables were included in the regression showed general tendendcy about zero with a large increase in variance noted around the fortieth week. When the regression was performed with the variables identified by the stepwise process, a

similar residual plot was obtained. As a first modification, a qualitative variable indicating the Fourth Quarter was included. This yielded an increase in $\bar{R}^2$, but did not significantly reduce the variance range. The expenditure phenomenom of the Fourth Quarter is characterized by widely fluctuating expenditures from week to week. The model is very sensitive to this type of change and cannot predict the large, abrupt changes in comittments.

Computer listings in support of above calculations are located in Appendix I.

C. SECOND BATTALION, FIRST BRIGADE

1. Results

Summary of the results listed in Table IV.

TABLE IV

Regression Summary-Second Bn., First Bde.

ACTION	VARIABLES IN MODEL	R^2	R^2 ADJUSTED
Regression on all variables	Lag 1-Lag 6, On-Ex, Pre-Ex, Post-Ex	62.5	53.2
Stepwise Regression	Lag 1, Lag 2, On-Ex, Post-Ex	59.02	-
Regression on selected variables	Lag 1, Lag 2, On-Ex, Post-Ex	56.2	55.2
Modification-Add Fourth Quarter effect	Lag 1, Lag 2, On-Ex, Post-Ex, Fourth	59.7	55.2
Modification-Drop On-Ex	Lag 1, Lag 2, Post-Ex, Fourth	59.5	56.0

2. Discussion

Regression of the initial variables indicated the presence of the Fourth Quarter effect and a tendency toward positive residuals. Positive residuals indicate the model is underpredicting the cost/day. Regression of the stepwise selected variables centered the distribution of the residuals toward zero but created some outlier points, especially for weeks in the Fourth Quarter. When the Fourth Quarter effect was included, it reduced the underprediction somewhat and removed some of the effect of influential Lag 1 values. The R^2 value is acceptable but the variability of the Fourth Quarter is still obvious. When the variable On-Ex was removed, the R^2 value stayed the same, implying that On-Ex is not a significant variable. After final modification, underprediction is still indicated and the Fourth Quarter still shows the presence of a variable not identified in the basic model formulation.

Computer listings in support of calculations located in Appendix J.

D. THIRD BATTALION, FIRST BRIGADE

1. Results

Summary of the results listed in Table V.

2. Discussion

Regression of initial variables shows a "right opening horn" residual plot. The "horn" indicates the variance associated with end of year expenditures and the influence of outlier values in higher lags. Reduction in the amount of lag varaibles as indicated by the stepwise procedure isolated the "horn" toward the start of the Fourth Quarter. When the Fourth Quarter variable was introduced,

TABLE V

Regression Summary-Third Bn., First Bde.

ACTION	VARIABLES IN MODEL	R^2	R^2 ADJUSTED
Regression on all variables	Lag 1-Lag 6, On-Ex, Pre-Ex, Post-Ex	68.8	61.0
Stepwise regression	Lag 1, Lag 2, On-Ex,	55.11	-
Regression on selected variables	Lag 1, Lag 2, On-Ex,	54.9	52.0
Modification-Add Fourth Quarter effect	Lag 1, Lag 2, On-Ex, Fourth	56.1	52.2
Modification-Add Lag 3	Lag 1, Lag 2, On-Ex, Fourth, Lag 3	58.8	54.0

it reduced the variance slightly, indicating a stronger Fourth Quarter effect than an indicator variable could account for. This unit was seriously affected by a period of large negative costs/day, which influenced the least squares procedure througout the regression process. These large negative costs may have occurred through errors in requisitions, turn-in of previously requisitioned equipment with credit given, or errors in the TUFMIS system.

Computer listings in support of calculations located in Appendix K.

E. FIRST BATALION, SECOND BRIGADE

1. Results

Summary of the results listed in Table VI.

TABLE VI

Regression Summary-First Bn., Second Bde.

ACTION	VARIABLES IN MODEL	R^2	R^2 ADJUSTED
Regression on all variables	Lag 1-Lag 6, On-Ex, Pre-Ex, Post-Ex	48.4	35.5
Stepwise regression	Lag 1, Lag 2, On-Ex, Pre-Ex	46.34	-
Regression on selected variables	Lag 1, Lag 2, On-Ex, Pre-Ex	47.0	42.3
Modification-Add Fourth Quarter effect	Lag 1, Lag 2, On-Ex, Pre-Ex, Fourth	50.4	44.7
Modification-Drop Lag 2	Lag 1, On-Ex, Pre-Ex,	50.5	46.3

2. Discussion

On initial regression, this unit, as in all others previously examined, showed dramatic heteroscedacity in the Fourth Quarter. The marked variations in week to week daily cost negate the predictive power of the model and cause variance changes throughout the course of the year. When regression was performed on the selected variables, the variability of the residuals was significantly reduced. On the inclusion of the Fourth Quarter variable, the residual variance was further reduced but the heteroscedacity of the Fourth Quater weeks still remained. Removal of the Lag 2 factor was done to limit the effect of cost/day changes.

This improved the adjusted R^2 value but did not remove the Fourth Quarter variance.

Computer listings in support of calculations located in Appendix L.

F. SECOND BATTALION, SECOND BRIGADE

1. Results

Summary of the results listed in Table VII.

TABLE VII

Regression Summary-Second Bn., Second Bde.

ACTION	VARIABLES IN MODEL	R^2	R^2 ADJUSTED
Regression on all variables	Lag 1-Lag 6, On-Ex, Pre-Ex, Post_Ex	48.1	35.2
Stepwise regression	Lag 1, Post-Ex	42.77	-
Regression on selected variables	Lag 1, Post-Ex	49.3	47.3
Modification-Add Second quarter effect	Lag 1, Post-Ex, Second	49.3	46.2
Modification-Remove Second	Lag 1, Post-Ex	49.3	47.3

2. Discussion

Regression on initial variables indicated overprediction but did not show the marked Fourth Quarter effect noted in the other units. Regression on the stepwise selected variables increased the adjusted R^2, but did not reduce the overprediction. Introduction of the Second Quarter effect did little to improve the model.

The model for this unit was adversely affected by abrupt changes in cost/day from week to week. Differential costs in excess of $1000 per day caused large variations in the residuals over a very short time span.

Computer listings in support of calculations located in Appendix M.

G. THIRD BATTALION, SECOND BRIGADE

1. Results

Summary of the results listed in Table VIII.

TABLE VIII
Regression Summary-Third Bn., Second Bde.

ACTION	VARIABLES IN MODEL	R^2	R^2 ADJUSTED
Regression on all variables	Lag 1-Lag 6, On-Ex, Pre-Ex, Post_Ex	57.7	47.1
Stepwise regression	Lag 1, Lag 2	55.46	-
Regression on selected variables	Lag 1, Lag 2	56.2	54.3
Modification-Add Fourth Quarter effect	Lag 1, Lag 2, Fourth	59.2	56.5

2. Discussion

Initial regression yielded a much larger R^2 than other units in this Brigade. The variation in residuals appeared to be isolated in the fourth quarter and at locations with large week to week cost differences. Regression of selected variables indicated the need for inclusion of Fourth Quarter effect due to the dramatic

changes in spending behavior. When the Fourth Quarter variable was added to the model, improvement in residual variance was noted, with the exception of several outlier points.

Computer listings in support of calculations located in Appendix N.

H. COMMENTS AND OBSERVATIONS

The performance of the linear regression model appears to be promising for prediction of daily costs with several dramatic exceptions. These are:

1. Fourth Quarter-The spending behavior associated with the the final quarter of the fiscal year is critical to the utility of the model. The "spend it or lose it" attitude that prevails during this period causes rapid changes in expenditure magnitude from week to week. Large transfers of funds between units are not uncommon during this period, dramatically altering an otherwise regular commitment pattern.The qualitative variables used by the model are not sensitive enough to take into account the changes in pattern. The lag variables, while providing a good indication of spending during the first three quarters, are markedly affected by cost/day differences in spending that occur in the fourth quarter.
2. Influence of outlier values-The inclusion of lag variables in the model accentuates the effects of large positive or negative daily costs. Although the smoothing process removed some of the outlier values, many still remain in the model. Due to the low resolution of the data source, the causes of the extraordinary costs can not be identified and thus

removed from the model. With a priori knowledge of the causes of the outlier costs, they could be trimmed from the data base to improve predictive capability.

VI. SUMMARY AND CONCLUSIONS

A. SUMMARY

Initially, the reader is exposed to the commander's concern for defining and allocating resources in support of the unit training program. The training management process is introduced, and the echelons of training requirements are discussed. The planning formats in support of the program development and their characteristics are listed. This thesis examines the roles of the two current Army methodologies, BTMS and TMACS, with a view toward the data collection requirements that they generate. An additional scheme, the Jaehne model, is examined. This method relieves the unit of much of the burden of data collection and provides a quick "rule of thumb" for expenditure analysis. The feasibility of this method is reviewed and its' applicability for employment as a fiscal expenditure control system is highlighted.

Historical data provides some indication of the relation of training activity to time. The confirmation of the Jaehne model demonstrates the value of inclusion of historical data in predicting training event cost. This thesis proposes to use an expanded historical data base in an effort to develop a mathematical model capable of predicting daily cost.

The proposed model utilizes multiple linear regression techniques. First, some of the characteristics of linear regression models are reviewed. Possible predictor variables in the unit training program are identified and a discussion of sources of data in support of these variables is made. These predictor variables are carried forward into

the analysis of the expenditures of six light infantry battalions for a complete fiscal year. Data analysis techniques isolate an initial listing of nine independent variables which are considered in the model fitting.

The model is fitted on a battalion by battalion basis by regressing on all the initial variables. Stepwise regression techniques are then employed to identify the more influential variables for further model fitting. Plots of the residuals after each phase of the modelling process imply the addition or deletion of other variables in the model. Variables attempting to account for end of the fiscal year spending phenomena provide some improvement in the predictive capability of the model but were lacking in removing the effect of the fourth quarter expenditures. Additionally, the effect of dramatic changes in magnitude of daily costs from week to week is illustrated by its' influence on the behavior of model residuals.

B. CONCLUSIONS

Based on the performance of the model on a low resolution historical data base, the following conclusions can be made:

1. Multiple linear regression models may be used to supplement and verify the information provided by the TMACS process.
2. Historical data may provide a useful predictor of future training costs.
3. The proposed historical data based model relieves the data collection burden of the unit.
4. The inclusion of additional relevant data into the model, such as the reasons for extremely high and low average expenditures, would definitely improve the predictive capability of the independent variables.

C. IMPLEMENTATION

Existing divisional micro and mini computer support systems could be expanded to do the calculations and maintain the data base necessary to support this methodology.

Additional purchases of software should include statistical packages which contain multiple linear regression routines.

D. SYSTEM CONTROL

Control of the system at division level would be the responsibility of the Division G-3. The Division G-3 is responsible to the Division Commander for operational control and training proficiency of divisional units. Since the proposed methodolgy supports training resource management, it should fall under the control of the staff section currently responsible for division training.

The proposed system could serve as a complementary method to TMACS, providing a cost estimate for comparison with the costs determined through the detailed cost factor method.

E. RECOMMENDATIONS FOR FUTURE STUDY

Based on the results of the potential utility of this model, the following areas for further study are recommended:

1. The applicability of this type of model in predicting direct support maintenance costs and training costs for combat, combat support and combat service support units should be investigated.
2. A test of the techniques with a higher resolution of data, to include the explanation of outlier values,

should be made to isolate the effects of large variance observations on the model.

3. An investigation of location peculiar influences should be done by comparing the expenditures of like battalions on different installations.
4. The data base should be expanded to include more than one fiscal year. Inclusion of several years in the data base necessitates adoption of a weighting scheme. Recent data points are given more wieght in the model than points obtained early in the data base.

The Battalion Commander of the 1980's, confronted by demands for resource management at the unit level, can effectively employ existing data sources with minimal time and expertise to adequately predict daily cost.

APPENDIX A
TRAINING EVENT CATEGORY ISSUE DEFINITIONS

These definitions are extracted from the Training Management Control System Cadre Training Packet published by Headquarters, US Army Forces Command, Fort McPherson, Georgia, dated April 1982.

1. Training of Battalions -Resources required to provide individual through battalion level collective training in Army units.
   a) Individual Soldiers's Manual/Aircrew Training Manual Training -Category accounting for individual and crew training that must be accomplished separately from unit collective training. Examples: Soldiers Manual training, maintenance training, Expert Infantryman training.
   b) Individual Weapons Training -Category accounting for training in individual weapons proficiency. Examples: M-16 field and record fire, pistol familiarization and qualification, LAW training.
   c) Squad/Crew Soldier's Manual, ARTEP, and Aircrew Training Manual Training -Category accounting for squad/crew level proficiency training. Examples: Squad/crew level ARTEP task training with integrated Soldier's Manual training, squad live-fire training and evaluation.

d) Crew Served Weapons Training -Category accounting for training conducted in crew served weapons. Examples: TOW qualification, M-60 machine gun qualification.

e) Weapons System Gunnery -Category accounting for major battalion level weapons systems. Examples: Tank gunnery, attack helicopter gunnery.

f) Platoon and Company Soldier's Manual/ARTEP Training and Evaluation -Category accounting for training conducted at platoon and company level. Examples: Garrison and field ARTEP task training.

g) Contingency Mission/Special Environment Training -Accounting for resources required for training for contingency missions the do not correlate directly with ARTEP missions and that are required for training individuals and units for operations in mountain, northern, jungle, desert, amphibious environments or other special environments. Examples: civil disturbance training, reconnaissance of contingency mission sites.

h) Unit Exchange with Allied Nations -Accounts for resources associated with the exchange training program.

i) Battalion Soldier's Manual/ARTEP Training (FTX) -Accounts for resources provided for battalion level training required to overcome deficiencies found on ARTEP evaluations in the Field Training Exercise mode. Training consists of battalion level ARTEP tasks.

j) Battalion Soldier's Manual/ARTEP Training (CPX/TEWT) -Accounts for training in battalion

level tasks conducted in Command Post Exercise/Tactical Exercise Without Troops mode.

k) Battalion External Evaluations -Accounts for resources required for battalion external evaluations.

l) Emergency Deployment/Employment Training for Units -Accounts for resources necessary to conduct training for Emergency Deployment Readiness Exercises, Unit Readiness Tests and alerts.

m) Combined Arms Live Fire Exercise -Accounts for resources consumed in defensive or offensive combined live fire exercise for maneuver units augmented by an appropriate portion of divisional and combat support elements.

n) Other -Accounts for resources consumed in battalion training events not applicable to other categories.

2. Training of Brigades and Divisions -Accounts for resources required to provide deployment, command and control, and sustainment training to brigades, divisions and corps. Resources shown provide fuel, spare parts, transportation, travel, and supplies to support training to the basic proficiency levels required by war plans and specific contingency missions.

a) Brigade Command Post Exercise (CPX) -accounts for resources for field or garrison command post exercise or computer simulation.

b) Division Command Post Exercise (CPX) -Accounts for resources for division CPX or computer simulation. This includes all subordinate units supporting the CPX.

c) Corps Command Post Exercise -Accounts for resources for corps CPX or computer simulation. This includes subordinate units supporting the CPX.

d) Brigade Emergency Deployment/Employment Training -Accounts for resources for brigade level Emergency Deployment Readiness Exercises, Unit Readiness Tests, and alerts.

e) Brigade Field Training Exercises -Accounts for resources provided for brigade level field exercises with participation by the brigade headquarters and headquarters company, an appropriate portion of divisional combat support, and combat service support elements, and at least one maneuver battalion.

f) Division Field Training Exercise -Accounts for resources provided for division level field exercises with participation by the division headquarters and headquarters company with organic combat, combat support, and combat service support elements.

g) Corps Field Training Exercise -Accounts for resources provided for Corps level field exercises.

h) Other -Accounts for resources provided for Brigade and higher level training events which do not fit the above categories.

3. Special Requirements (MACOM unique) -Accounts for resources provided for recurring responsibilities necessary for total force readiness. Resources provide fuel, spare parts, transportation, travel, and supplies to support field and garrison assistance to other Army and US Government activities by Army units.

4. Unit Mission Activity (MACOM unique)

   a) Operational Mission Activity -Accounts for resources required to accomplish assigned operational missions.

   b) Unit Mission Support Activity -Accounts for resources required to support other units on operational missions.

   c) Other -Accounts for mission activities which do not fall under either of the above two categories.

5. Force Sustainment -Accounts for P2 mission costs incurred by units to exist every day of the year in the force structure (billeting, administrative and logistical costs) with the exception of units performing 24 hour operational missions. Force sustainment costs will continue to be incurred while the unit is conducting training and should be viewed as the cost of ownership of having the unit in the force structure while conducting no training. These resources are considered fixed costs.

   a) Support to Installations/Local Communities -Accounts for P2 Mission resources used for installation housekeeping functions and special

requirements. Combat support and combat service support units providing installation support must assess the training value obtained from providing support and determine which funding issue resources should be applied to.

b) Garrison Operational Fixed Costs -Accounts for fixed cost resources computed as the costs remaining after all training and support costs are identified.

c) Other Costs -Accounts for other force sustainment costs not categorized in the above two categories.

6. Participation in Joint Exercises

a) Participation in Joint Exercise (Externally Funded) -Accounts for unit participation in externally directed and funded (JCS,REDCOM) Joint Training or Readiness Exercises.

b) Participation in Joint Exercises (Internally Funded) -Accounts for unit participation in Army MACOM directed and funded Joint Training or Readiness Exercises.

APPENDIX B

KEY TRAINING EVENTS OF FIRST BRIGADE UNITS

WEEK(S)	EVENT(S)
1-4	Jungle Operation Training Center
16-17	Squad ARTEP
21-23	Battalion Combat Training Team
34-35	Battalion ARTEP
39-40	Division Field Training Exercise
50-52	Company Amphibious Raid Course Field Training Exercise

Figure B.1 Major Training Events of First Battalion.

WEEK(S)	EVENT(S)
16-17	Field Training Exercise
21-22	Support of Reserve Component Annual Training
24-25	Field Training Exercise
28-31	Unit Exchange Program
34-35	Field Training Exercise
39-40	Division Field Training Exercise
41-43	Field Training Exercise
46-53	Joint Readiness Exercise

Figure B.2 Major Training Events of Second Battalion.

WEEK(S)	EVENT(S)
7-8	Military Operations on Urbanized Terrain
16-17	Platoon ARTEP
34-35	Field Training Exercise
39-40	Division Field Training Exercise
45-46	Support of Reserve Component Annual Training
50-52	Field Training Exercise

Figure B.3 Major Training Events of Third Battalion.

APPENDIX C
KEY TRAINING EVENTS OF SECOND BRIGADE UNITS

WEEK(S)	EVENT(S)
1-2	Company ARTEP
5-6	Joint Readiness Exercise
19-21	Squad ARTEP
29	Squad Evaluations
30-31	Platoon ARTEP
32-36	Unit Exchange Program
36-37	Platoon ARTEP
39-40	Division Field Training Exercise
46-48	Company ARTEP

Figure C.1 Major Training Events of First Battalion.

WEEK(S)	EVENT(S)
19-21	Platoon ARTEP
28	Support of Reserve Component Annual Training
29-30	Squad ARTEP
32-33	Support of Reserve Component Annual Training
39-40	Division Field Training Exercise
41-44	Jungle Operations Training Center
46-48	Company ARTEP

Figure C.2 Major Training Events of Second Battalion.

WEEK(S)	EVENT(S)
18-19	Squad ARTEP
30-31	Platoon ARTEP
38-39	Support of Reserve Component Annual Training
39-40	Division Field Training Exercise
42	Battalion Command Post Exercise
45-46	Company ARTEP
49-50	Battalion Landing Operations Course

Figure C.3 Major Training Events of Third Battalion.

APPENDIX D

UNIT COST PER DAY-TUFMIS REPORTED DATA

This appendix lists the TUFMIS reported average cost per day. The cost for the three day FY-81 carry over period is denoted as Week 0. Negative daily costs, as indicated, resulted from:

1. Unit cancellation of a previous requisition (with credit given)
2. TUFMIS input error
3. Errors in submission of requisition (wrong price, quantity, etc)

	FIRST BRIGADE			SECOND BRIGADE		
WEEK	BN 1	BN2	BN3	BN1	BN2	BN3
0	1397.80	473.60	431.00	174.60	0	0
1	456.15	225.40	580.28	344.08	0	4.73
2	69.02	81.00	349.52	223.94	-1.15	-36.31
3	92.47	740.00	1307.41	158.30	17.59	515.63
4	210.01	1615.82	1041.54	1381.65	644.79	1395.79
5	175.10	983.50	379.40	88.70	102.70	363.00
6	672.68	2778.04	820.64	975.24	842.71	476.97
7	865.59	1344.12	561.22	675.26	660.44	495.53
8	323.55	82.81	328.69	411.69	422.71	201.85
9	639.65	259.40	569.61	792.73	795.67	-55.58
10	683.44	210.46	678.85	577.46	1071.77	510.79
11	153.61	1049.65	542.63	427.83	1218.24	1334.2
12	229.76	555.55	928.16	400.53	1261.60	1492.48
13	466.45	528.72	1972.00	823.00	678.90	1171.00
14	660.54	211.32	981.54	1572.93	1757.41	1471.19
15	1140.06	193.07	676.29	1822.33	2374.61	1662.05
16	3551.37	845.37	1221.87	1518.87	3489.37	2086.75

	FIRST BRIGADE			SECOND BRIGADE		
WEEK	BN 1	BN2	BN3	BN1	BN2	BN3
17	4.32	1800.16	14417.35	795.53	808.69	1314.66
18	217.25	384.12	1150.50	704.75	278.87	691.62
19	1666.85	6062.28	440.85	651.14	1585.42	1411.00
20	445.57	557.14	1191.85	307.85	346.42	3960.57
21	800.82	92.39	1745.62	1569.76	538.50	1986.17
22	-152.25	484.75	596.37	311.37	-392.50	-1057.75
23	-98.38	1257.00	1192.37	183.00	1796.00	-348.88
24	428.23	724.28	10066.19	461.28	70.28	-235.13
25	204.42	200.71	2319.42	554.71	-145.86	-28.29
26	360.57	278.15	1652.27	407.48	2244.24	53.42
27	756.00	213.70	3168.30	438.80	1621.90	126.00
28	151.14	1938.71	3501.28	558.42	1454.42	469.28
29	863.77	1716.40	1487.19	927.24	1610.79	1146.17
30	819.42	-369.15	1617.35	524.71	1135.57	982.21
31	794.26	-150.31	1285.44	552.28	1085.10	1336.83
32	551.36	976.57	-719.86	607.48	651.40	3028.83
33	91.22	-77.19	-584.47	226.75	625.44	603.40
34	691.54	587.63	798.68	1711.40	4558.85	1559.63
35	1004.25	2304.87	1230.50	517.25	824.25	493.75
36	1047.12	1013.10	510.75	961.04	2069.65	682.59
37	1683.56	1242.45	1546.97	1182.86	933.84	924.96
38	325.78	820.92	93.14	124.35	815.50	365.92
39	391.18	699.87	-490.21	490.18	845.44	364.77
40	997.26	286.22	-4418.07	2521.48	1260.28	576.38
41	2096.15	2224.28	-5727.14	1629.58	2535.09	1933.56
42	1394.21	2844.94	1409.41	2089.40	1467.59	1801.75
43	2047.87	3265.18	350.15	1708.76	730.87	702.70
44	4.15	2070.07	128.30	628.84	79.15	224.69
45	1261.96	2259.91	1525.07	2902.60	1165.53	1581.63
46	16293.48	6929.84	7979.22	-430.07	1586.01	1836.11
47	1076.36	813.90	1644.54	2318.54	847.09	3826.81

	FIRST BRIGADE			SECOND BRIGADE		
WEEK	BN 1	BN2	BN3	BN1	BN2	BN3
48	1282.35	644.49	2327.37	1532.86	1448.97	4187.45
49	306.36	155.14	488.18	678.83	614.36	954.48
50	214.36	169.18	580.14	560.87	468.00	1778.06
51	87.58	701.21	373.93	457.39	523.88	849.68
52	33.66	24.50	185.83	283.16	36.33	574.33

APPENDIX E

DATA ANALYSIS FIGURES

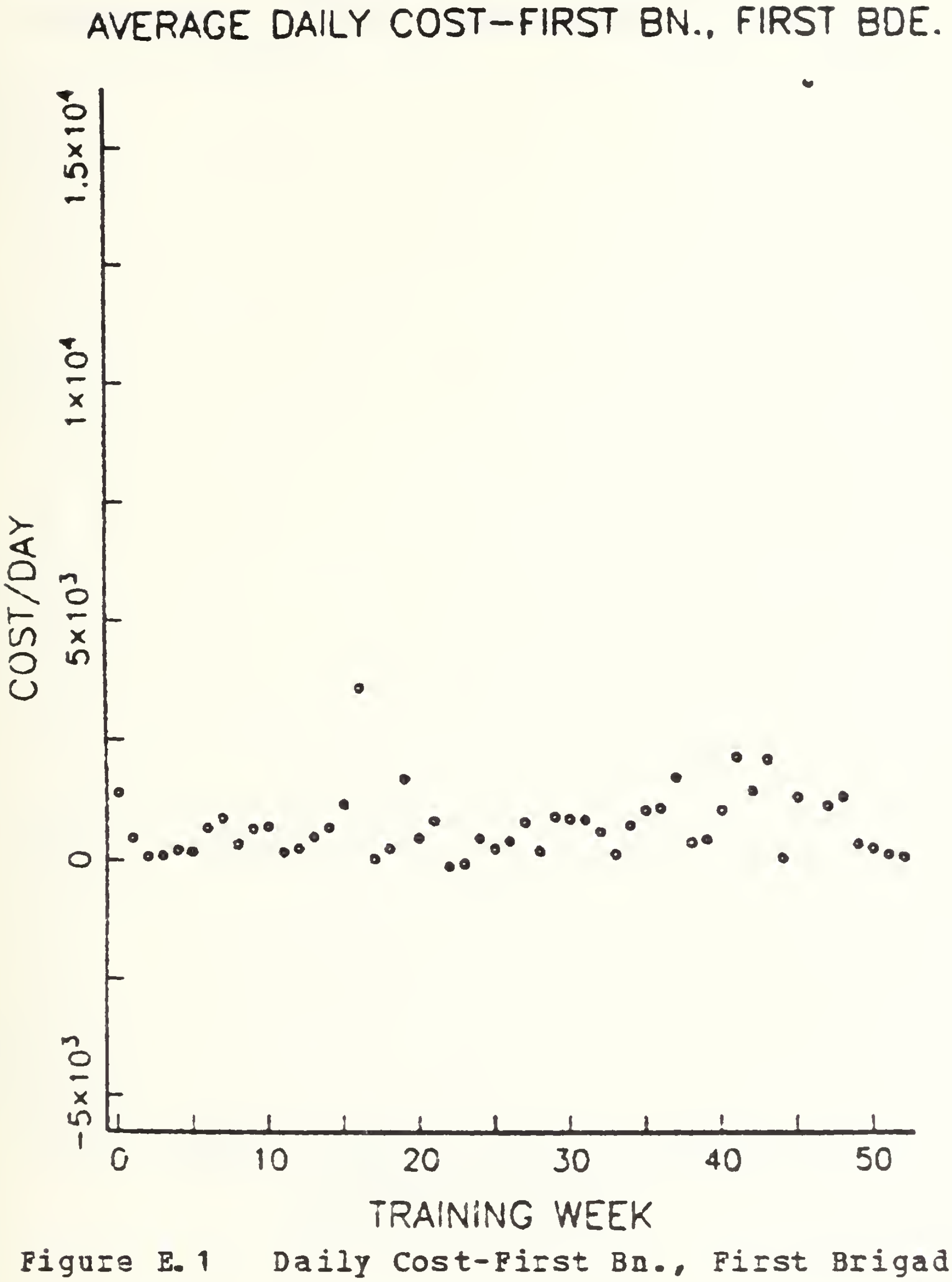


Figure E.1 Daily Cost-First Bn., First Brigade.

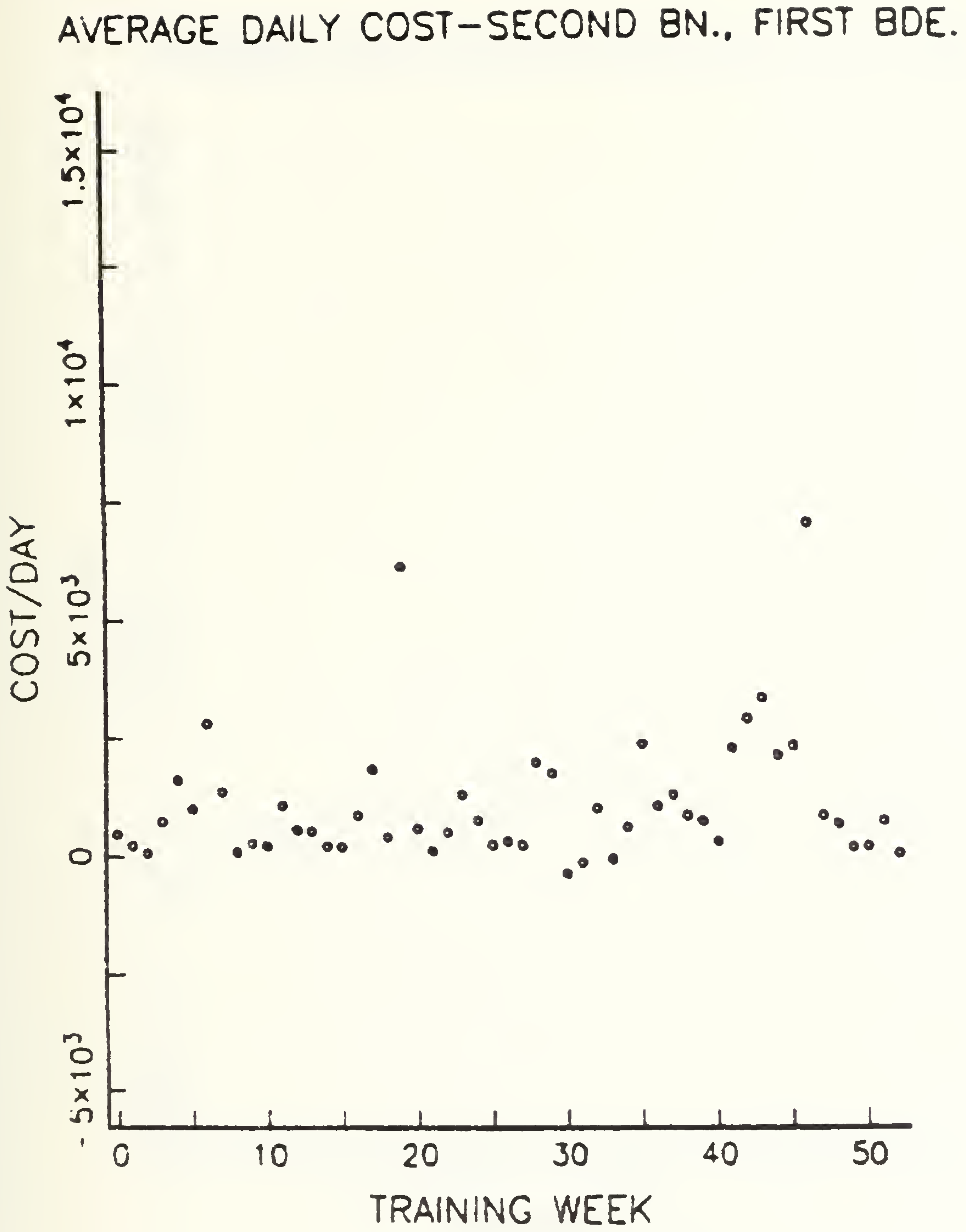


Figure E.2 Daily Cost-Second Bn., First Brigade.

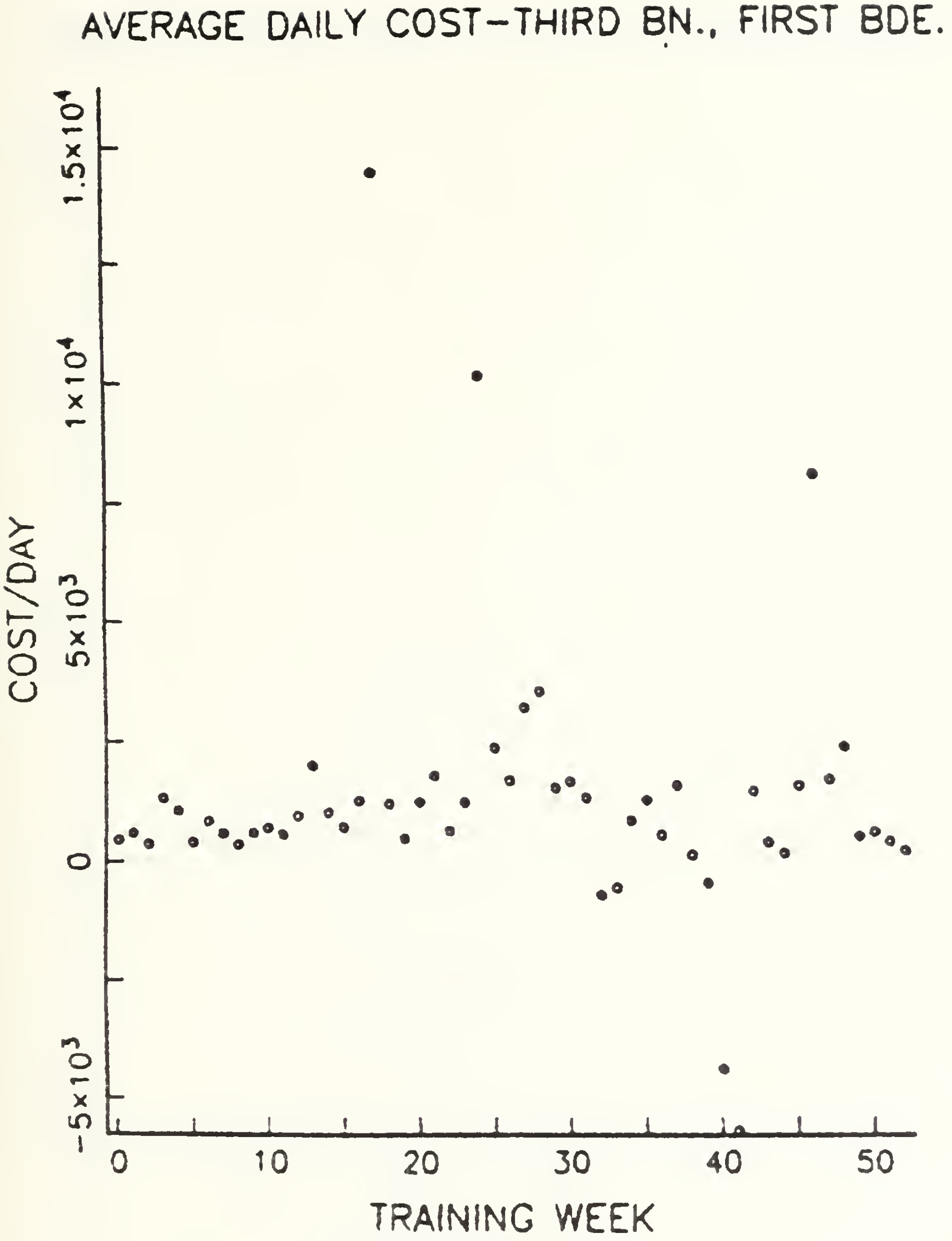


Figure E.3 Daily Cost-Third Bn., First Brigade.

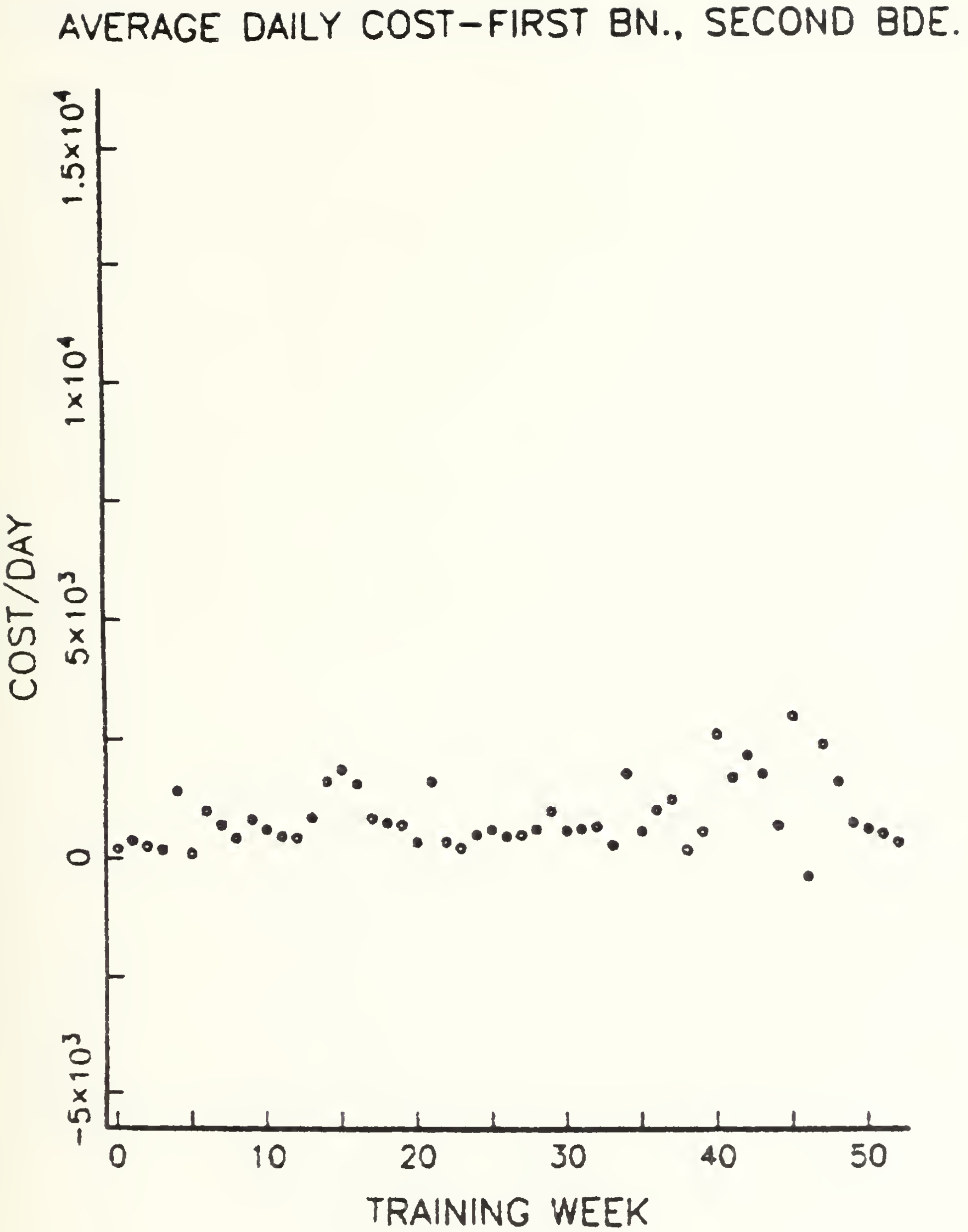


Figure E.4 Daily Cost-First Bn., Second Brigade.

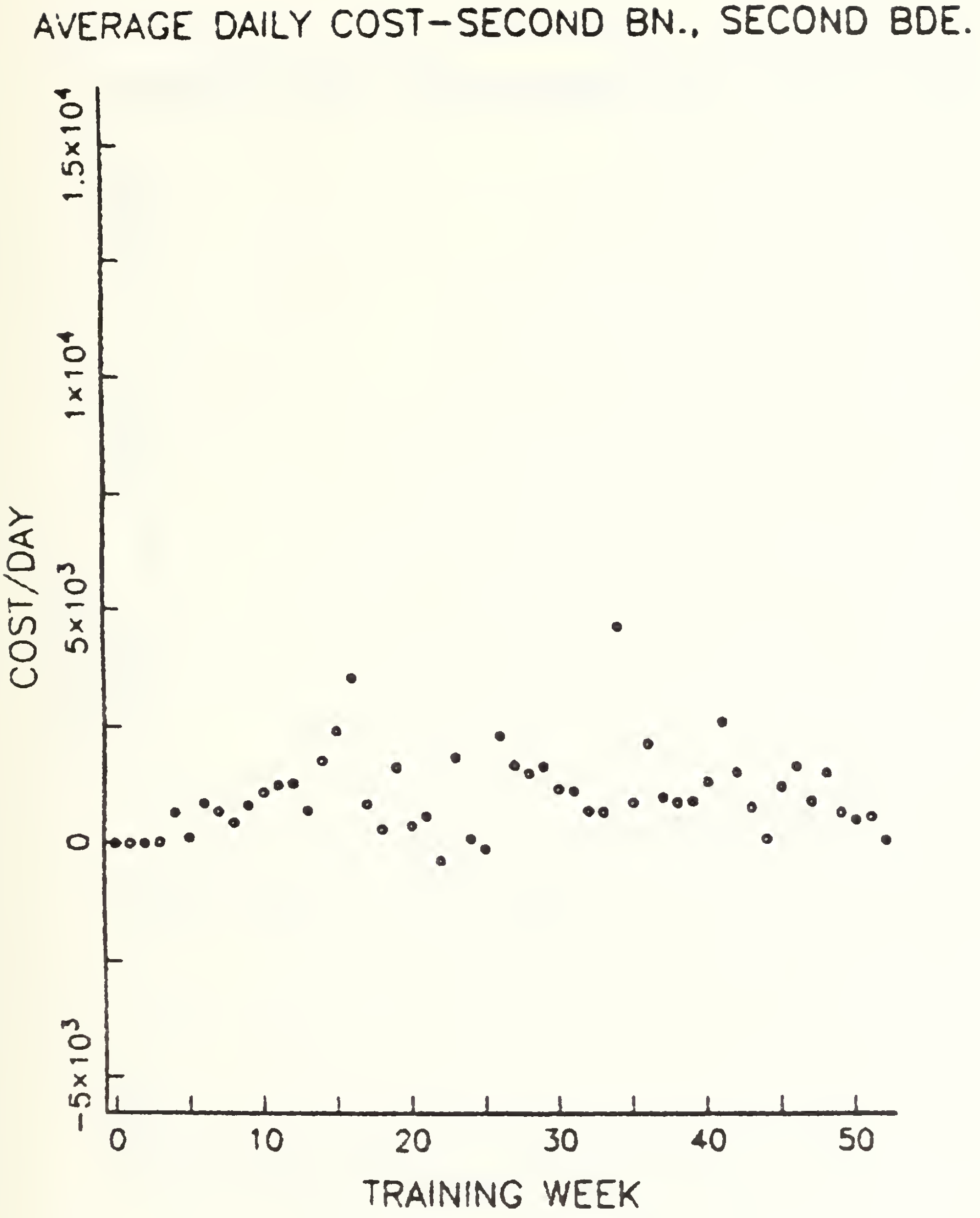


Figure E.5 Daily Cost-Second Bn., Second Brigade.

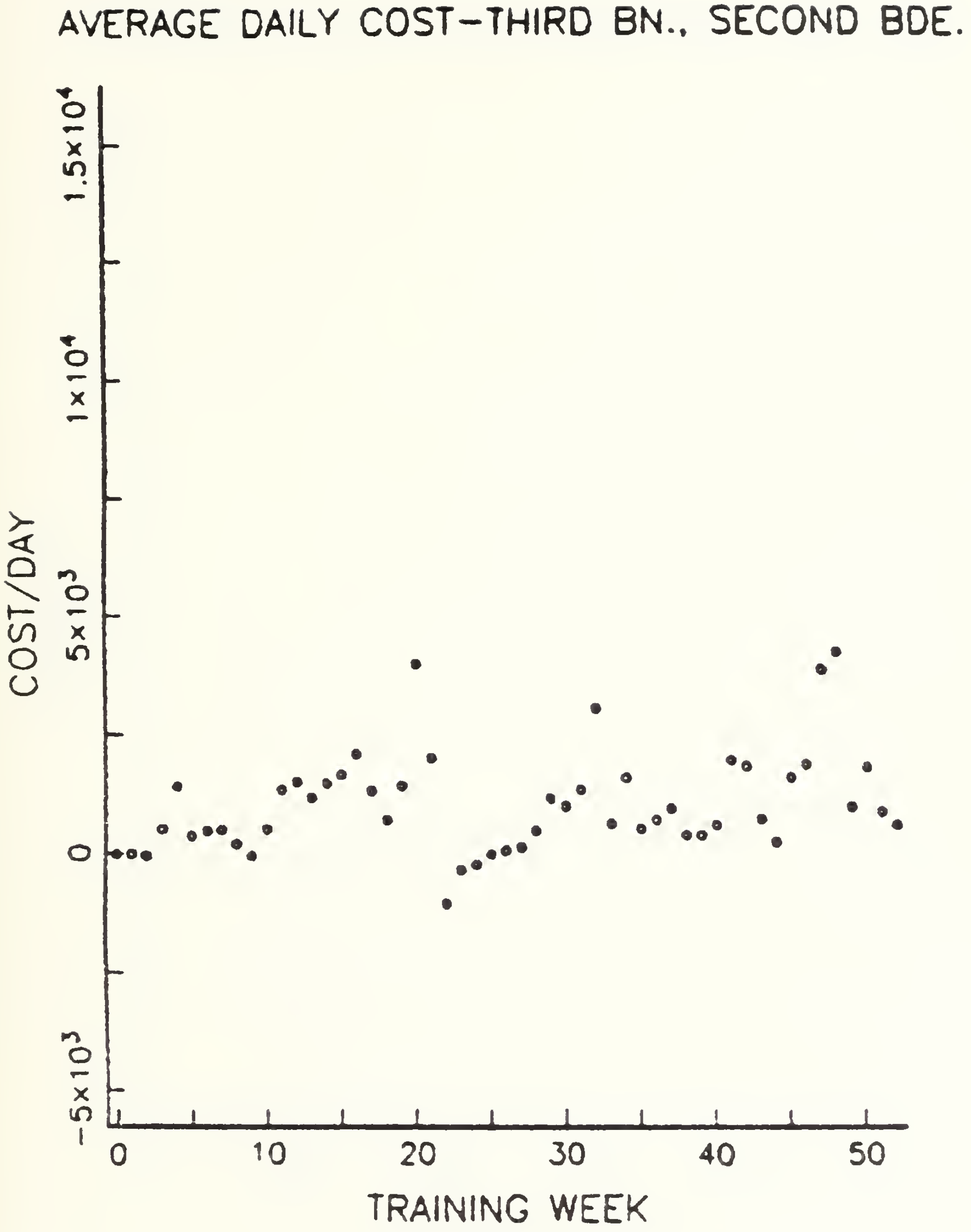


Figure E.6 Daily Cost-Third Bn., Second Brigade.

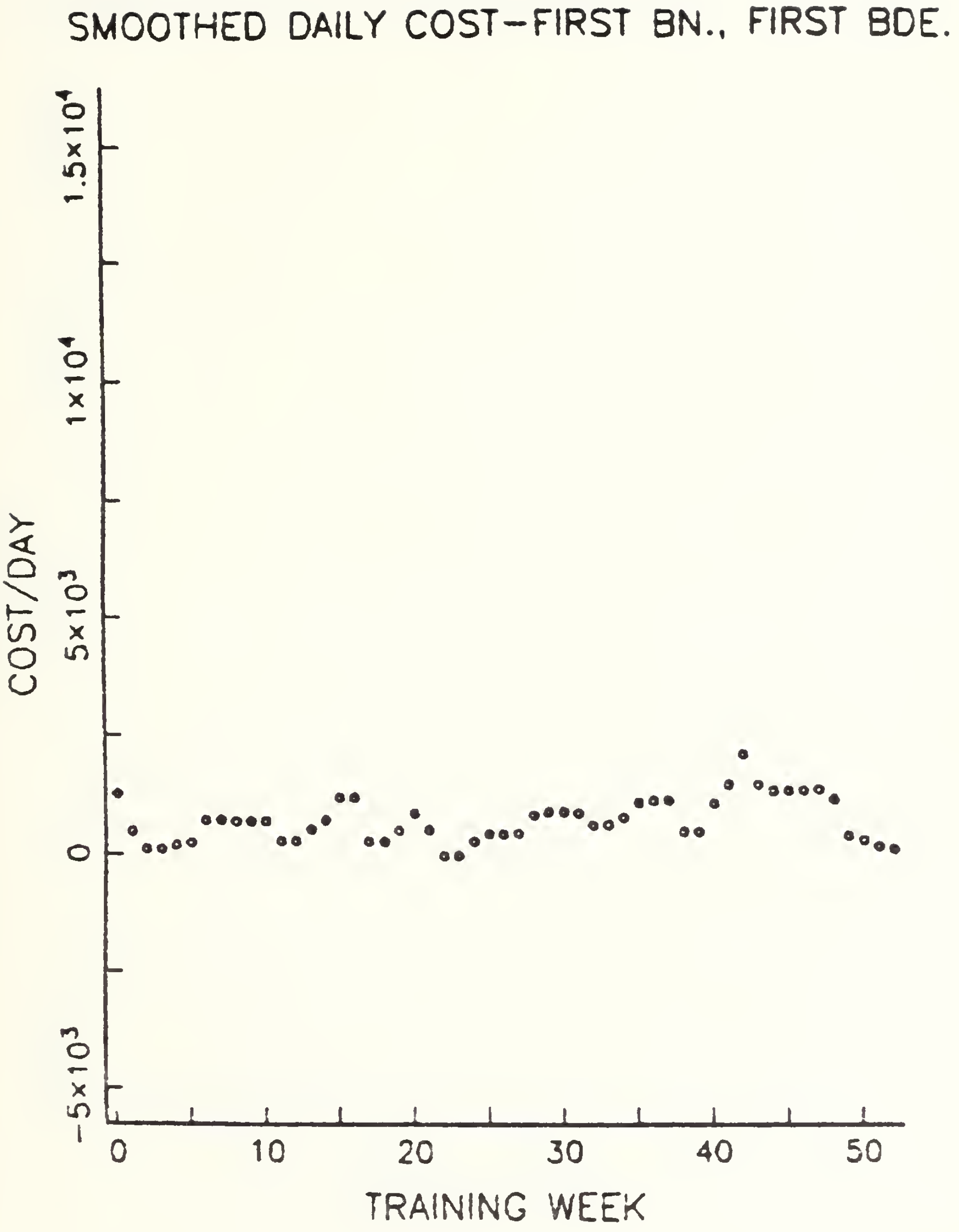


Figure E.7 Smoothed Cost-First Bn., First Brigade.

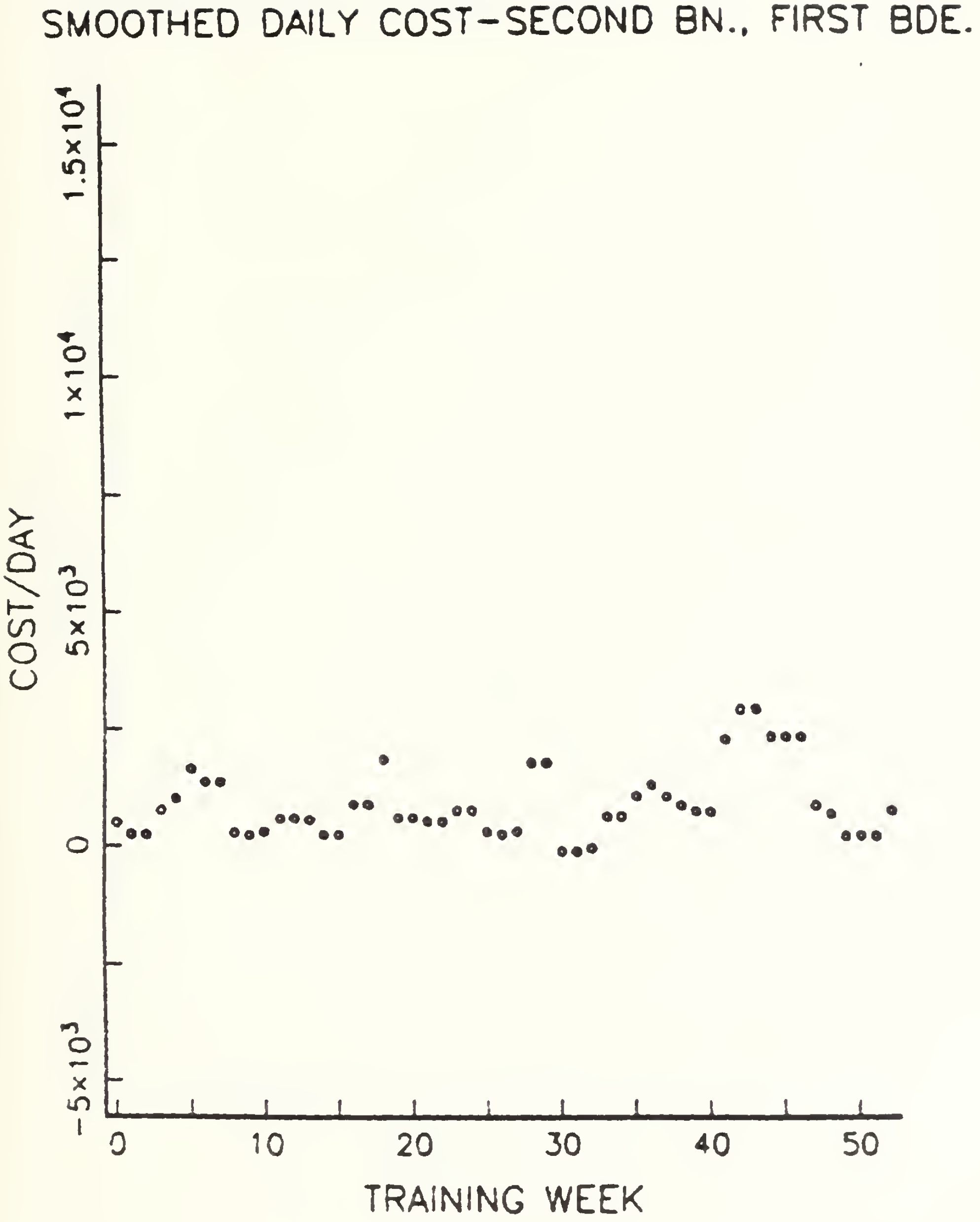


Figure E.8 Smoothed Cost-Second Bn., First Brigade.

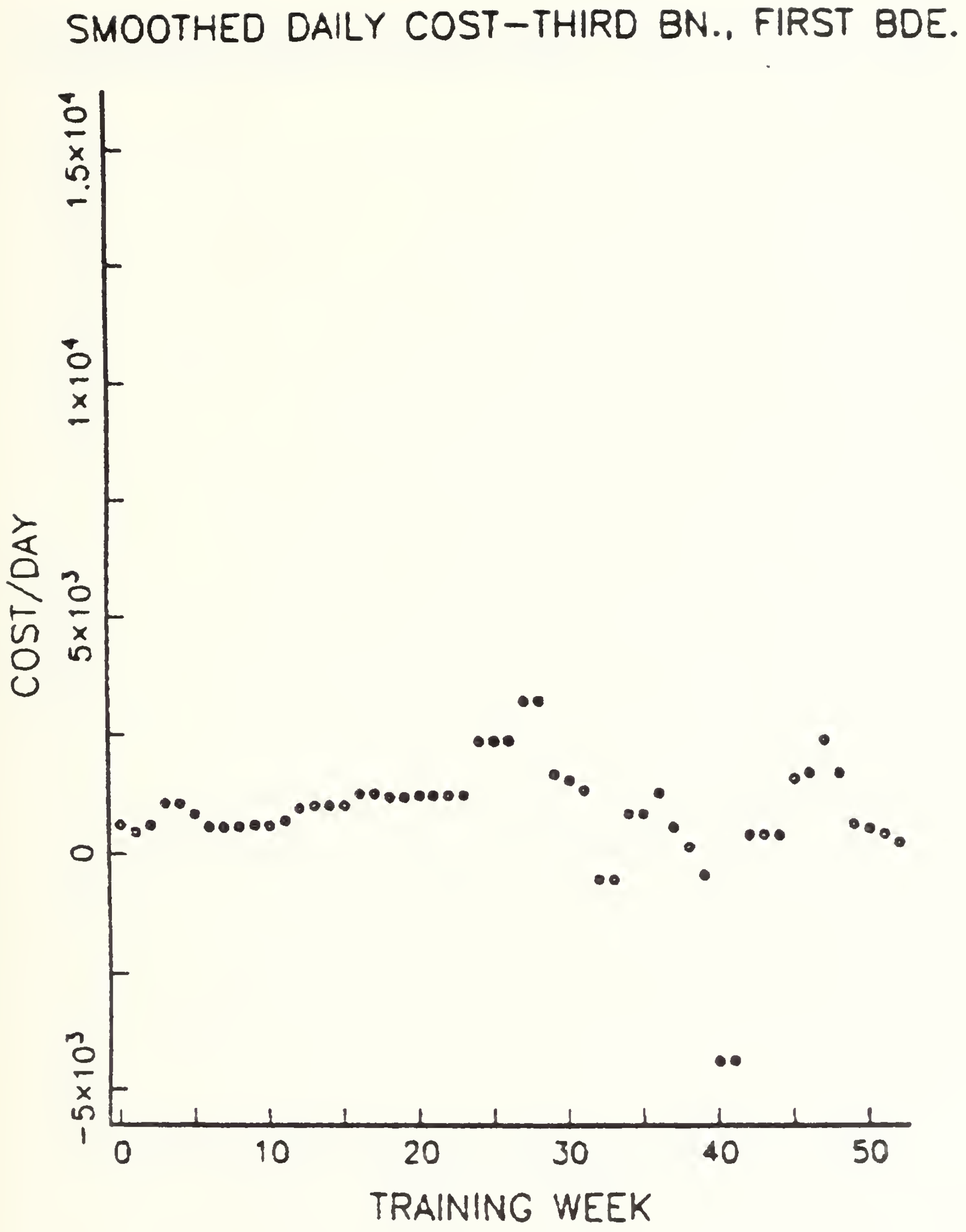


Figure E.9 Smoothed Cost-Third Bn., First Brigade.

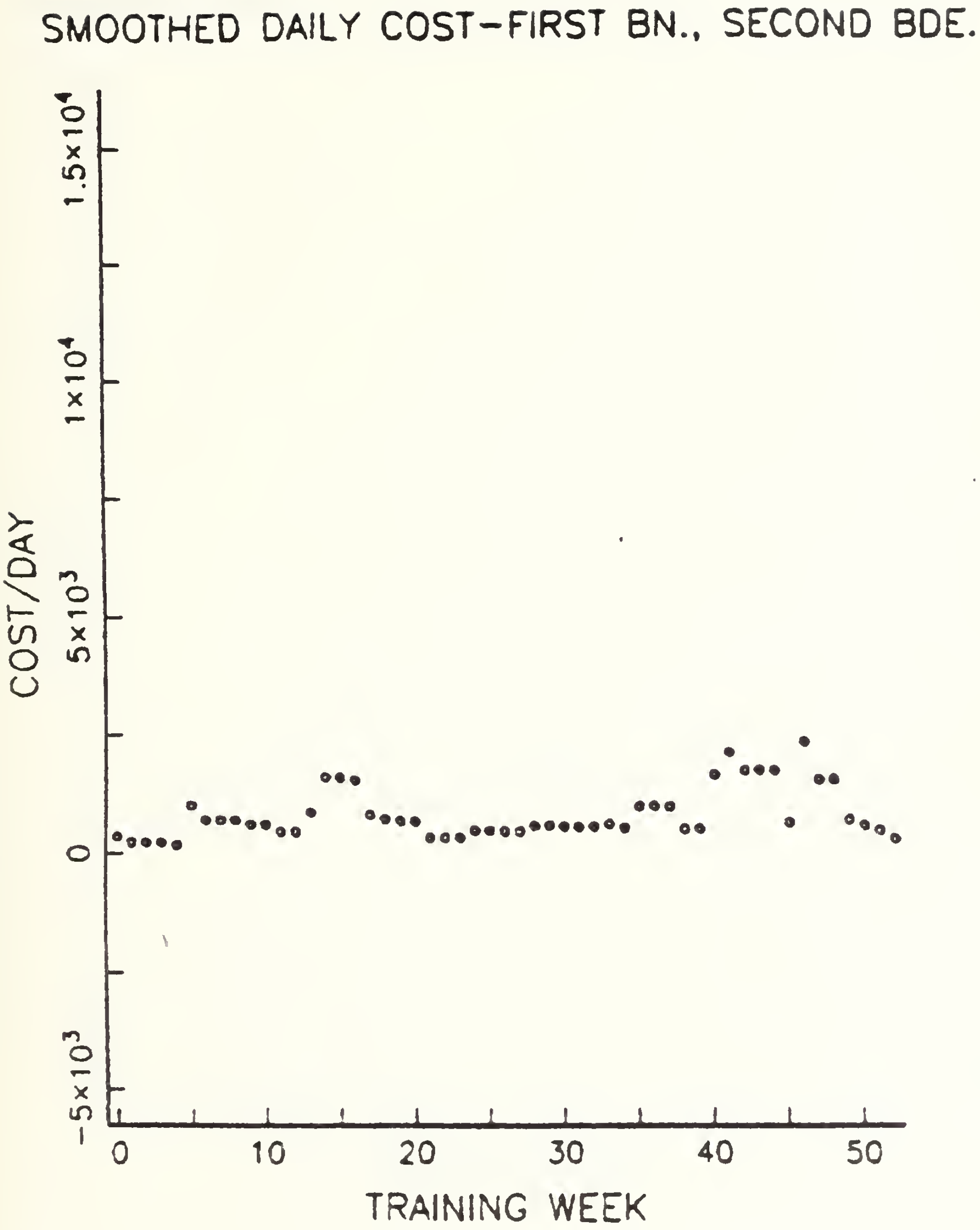


Figure E.10 Smoothed Cost-First Bn., Second Brigade.

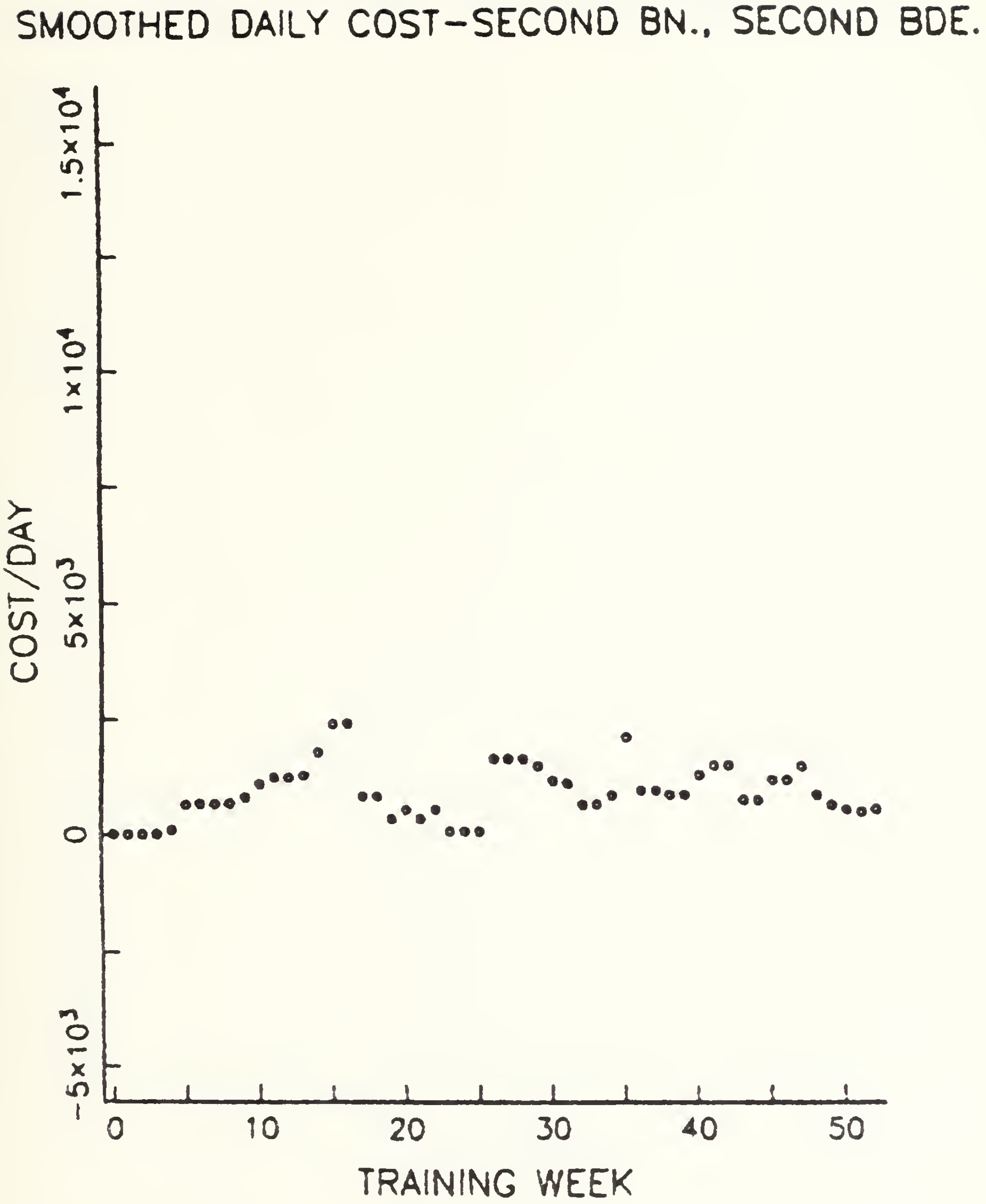


Figure E.11 Smoothed Cost-Second Bn., Second Brigade.

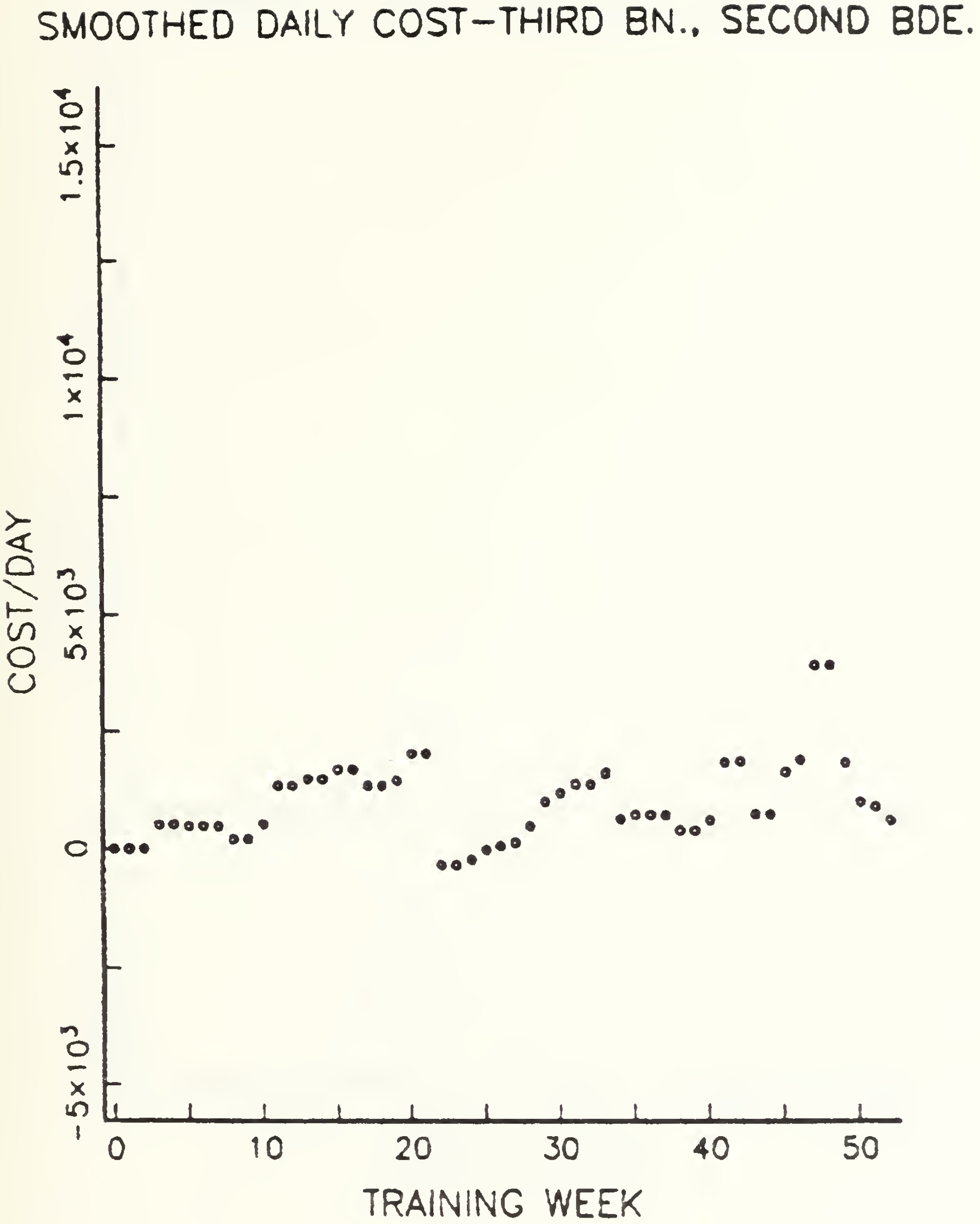


Figure E.12 Smoothed Cost-Third Bn., Second Brigade.

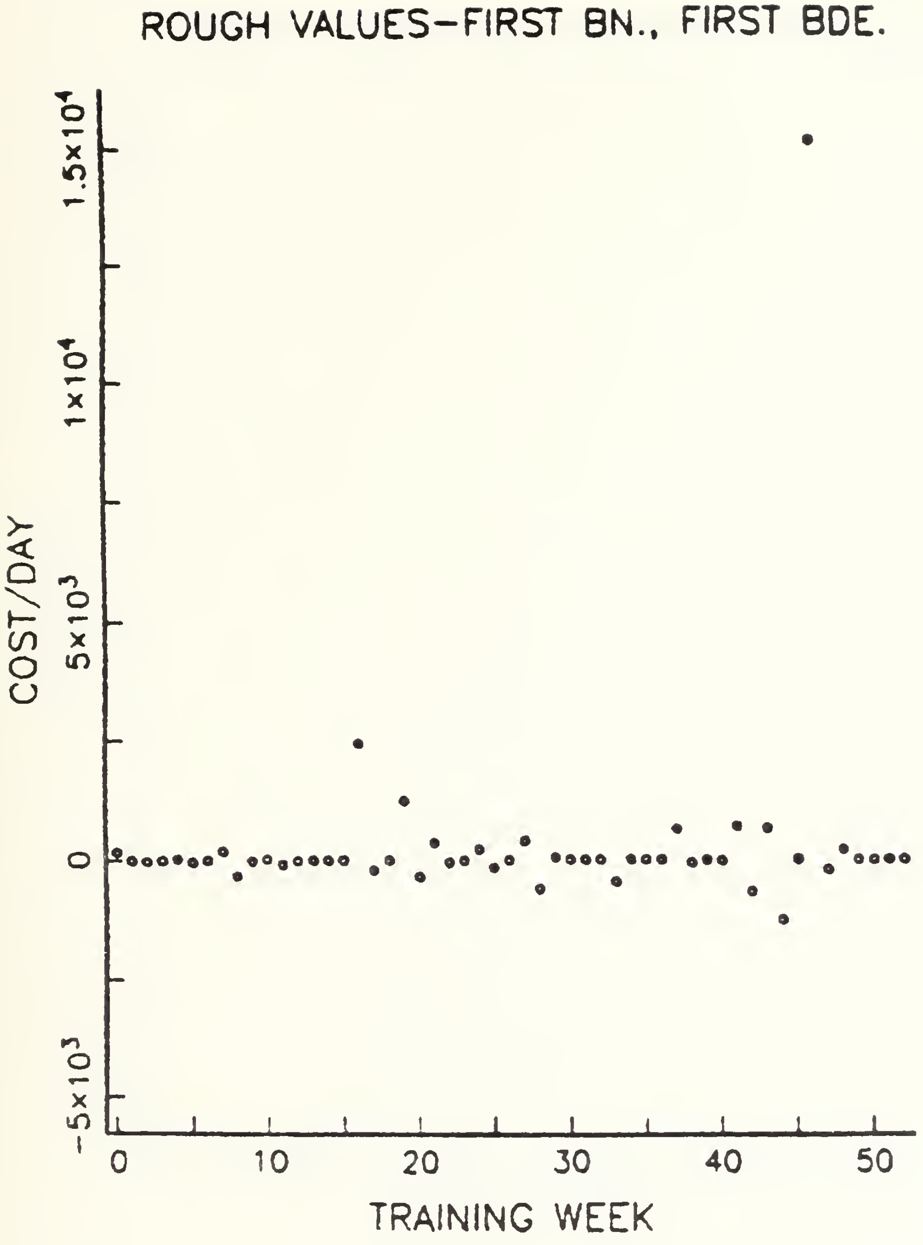


Figure E.13 Rough Values-First Bn., First Brigade.

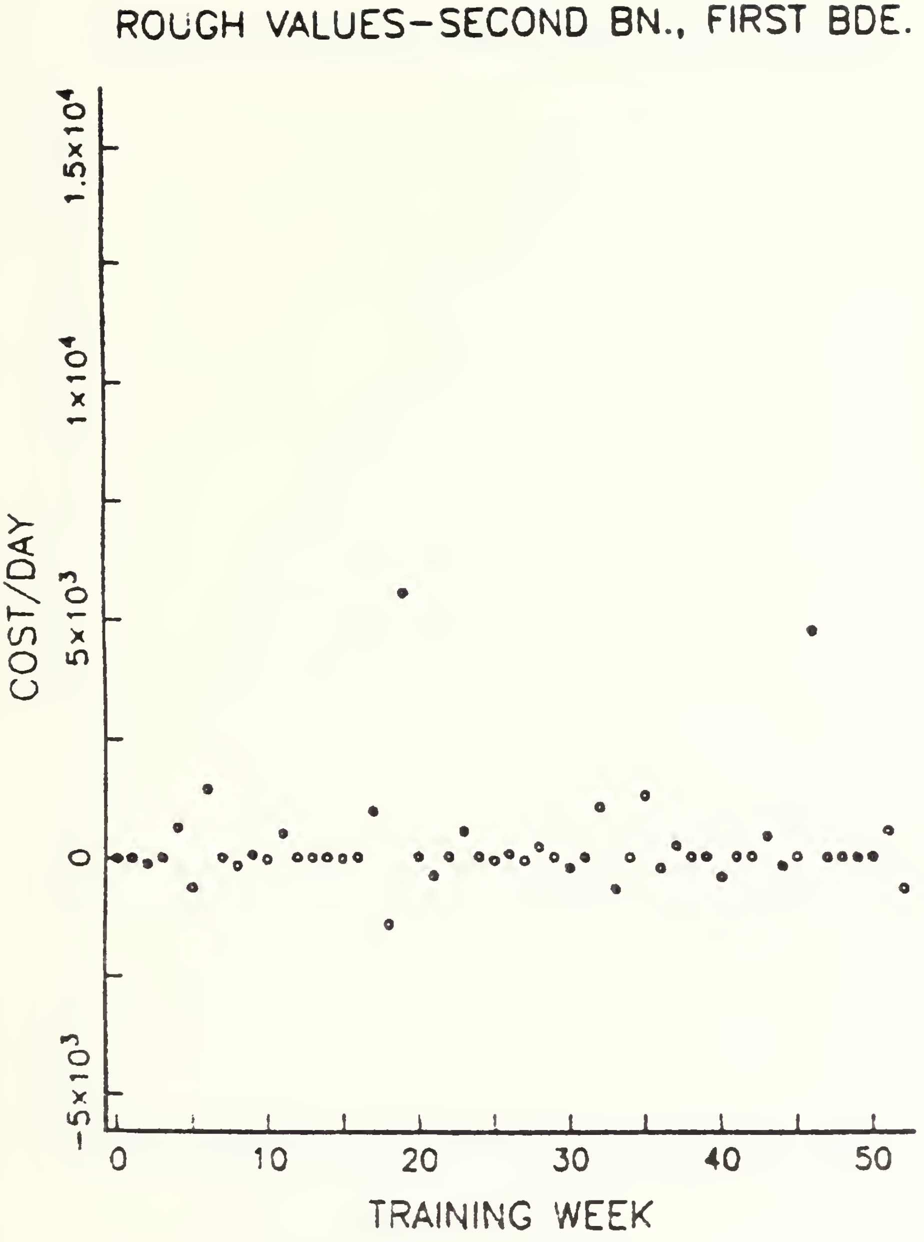


Figure E.14 Rough Values-Second Bn., First Brigade.

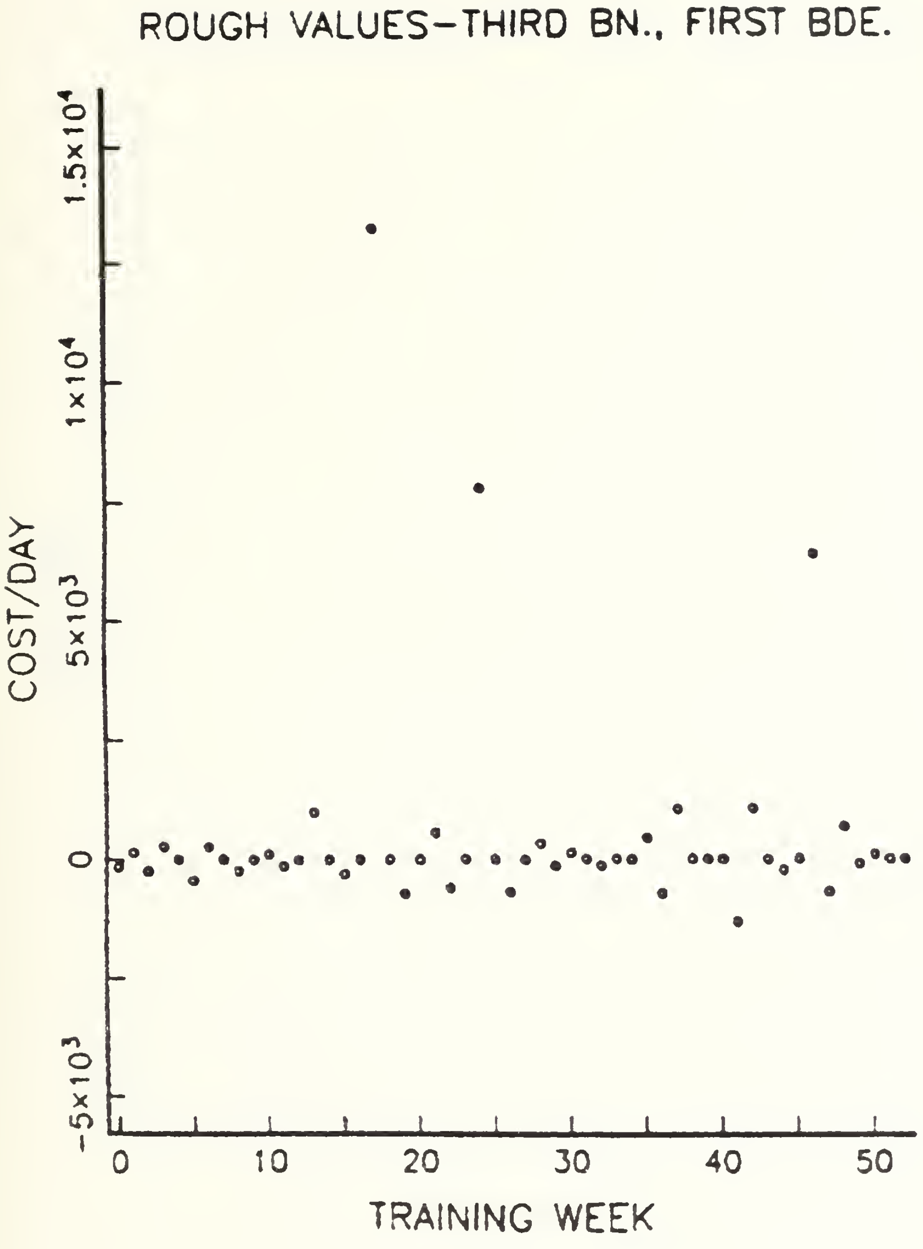


Figure E.15 Rough Values-Third Bn., First Brigade.

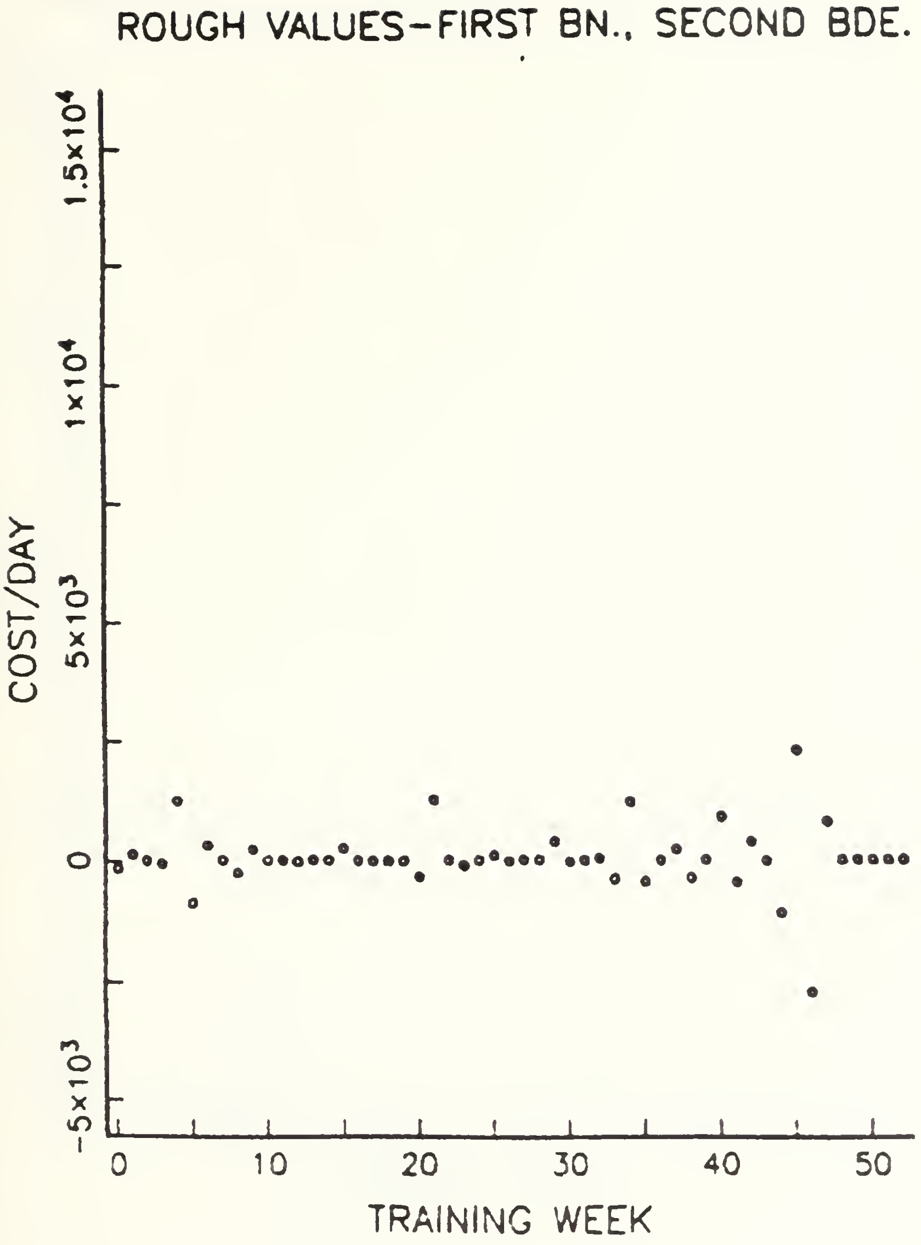


Figure E.16 Rough Values-First Bn., Second Brigade.

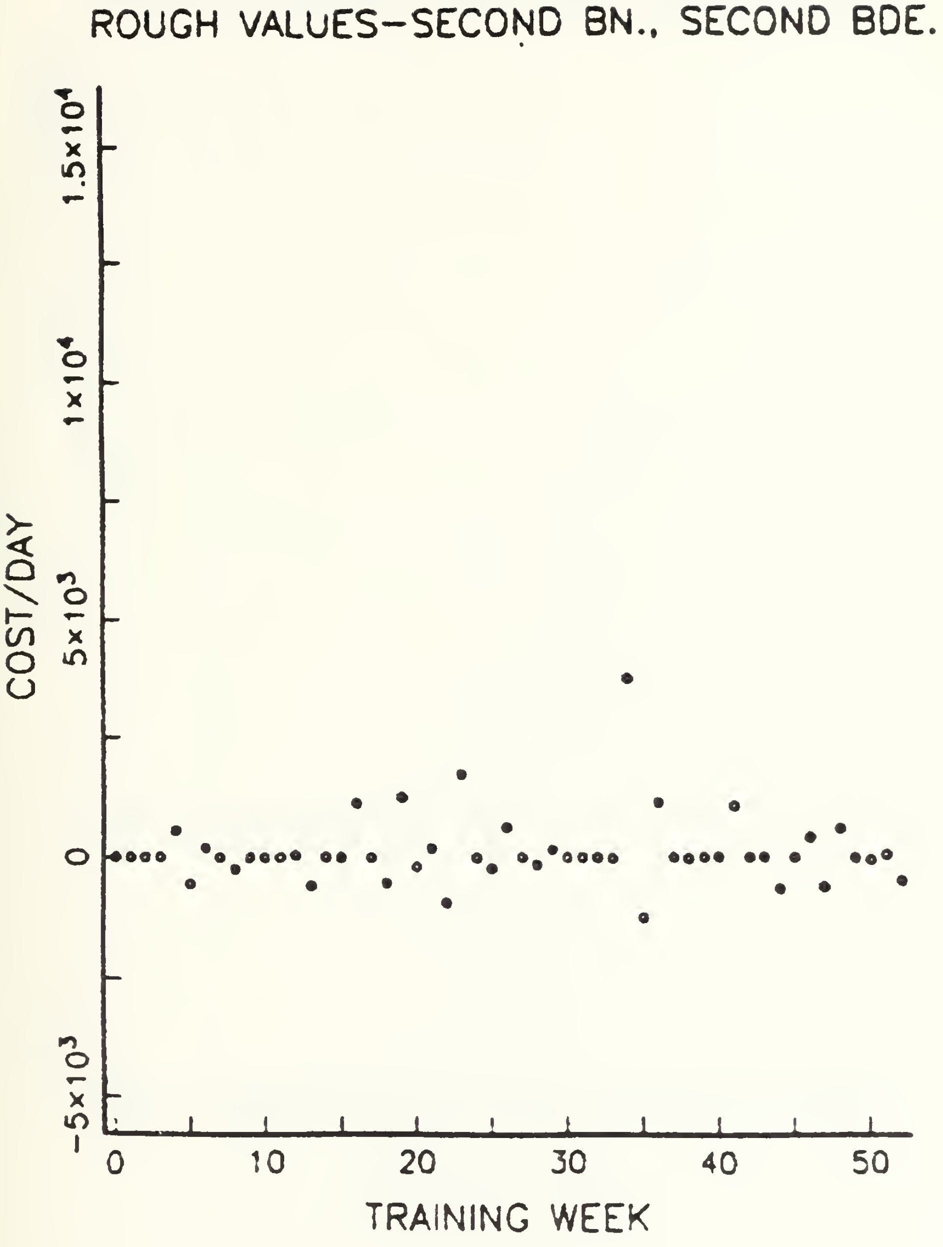


Figure E.17 Rough Values-Second Bn., Second Brigade.

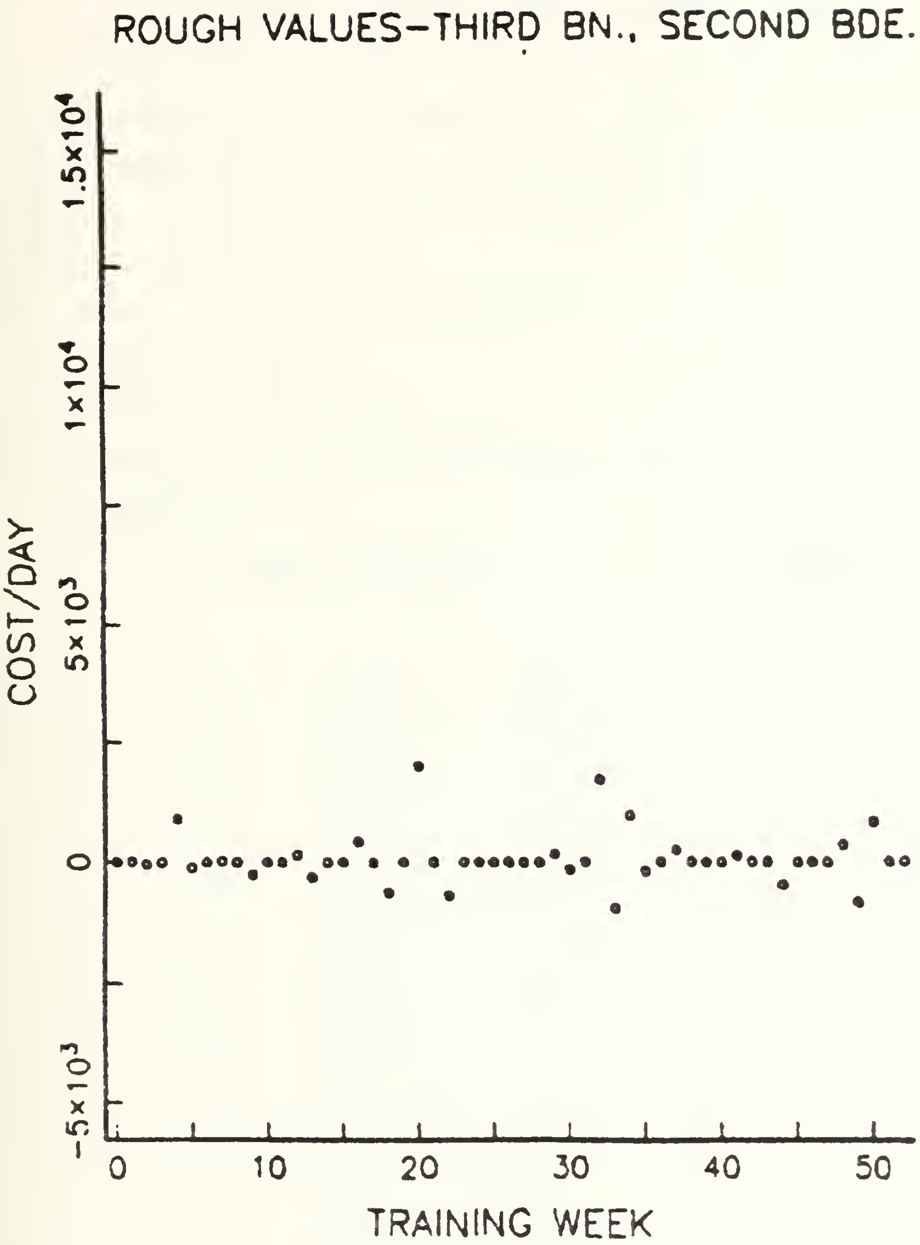


Figure E.18 Rough Values-Third Bn., Second Brigade.

APPENDIX F

UNIT COST PER DAY- SMOOTHED DATA

Data given in this appendix list the average cost per day for smoothed data. The cost for the three day FY-81 carry-over period is listed as Week 0. Negative costs, as indicated, result from:

1. Unit cancellation of a previous requisition (with credit given)
2. TUFMIS input error
3. Errors in submission of requisitions (wrong price, quantity, etc)

	FIRST BRIGADE			SECOND BRIGADE		
WEEK	BN1	BN2	BN3	BN1	BN2	BN3
0	1230.42	473.60	580.28	344.08	0	4.73
1	456.15	225.40	431.00	223.94	0	0
2	92.47	225.40	580.28	223.94	0	4.73
3	92.47	740.00	1041.54	223.94	17.59	515.63
4	175.10	983.50	1041.54	158.30	102.70	515.63
5	210.01	1615.82	820.64	975.24	644.79	476.97
6	672.68	1344.12	561.22	675.26	660.44	476.97
7	672.68	1344.12	561.22	675.26	660.44	476.97
8	639.65	259.40	561.22	675.26	660.44	201.85
9	639.65	210.46	569.61	577.46	795.67	201.85
10	639.65	259.40	569.61	577.46	1071.77	510.79
11	229.76	555.55	678.85	427.83	1218.24	1334.20
12	229.76	555.55	928.16	427.83	1218.24	1334.20
13	466.45	528.72	981.54	823.00	1261.60	1471.19
14	660.54	211.32	981.54	1572.93	1757.41	1471.19
15	1140.06	211.32	981.54	1572.93	2374.61	1662.05
16	1140.06	845.37	1221.87	1518.87	2374.61	1662.05

	FIRST BRIGADE			SECOND BRIGADE		
WEEK	BN1	BN2	BN3	BN1	BN2	BN3
17	217.25	845.37	1221.87	795.53	808.69	1314.66
18	217.25	1800.16	1150.50	704.75	808.69	1314.66
19	445.57	557.14	1150.50	651.14	346.42	1411.00
20	800.82	557.14	1191.85	651.14	538.50	1986.17
21	445.57	484.75	1191.85	311.37	346.42	1986.17
22	-98.38	484.75	1192.37	311.37	538.50	-348.88
23	-98.38	724.28	1192.37	311.37	70.28	-348.88
24	204.42	724.28	2319.42	461.28	70.28	-235.13
25	360.57	278.15	2319.42	461.28	70.28	-28.29
26	360.57	213.70	2319.42	438.80	1621.90	53.42
27	360.57	278.15	3168.30	438.80	1621.90	126.00
28	756.00	1716.40	3168.30	558.42	1610.79	469.28
29	819.42	1716.40	1617.35	558.42	1454.42	982.21
30	819.42	-150.31	1487.19	552.28	1135.57	1146.17
31	794.26	-150.31	1285.44	552.28	1085.10	1336.83
32	551.36	-77.19	-584.47	552.28	651.40	1336.83
33	551.36	587.63	-584.47	607.48	651.40	1559.63
34	691.54	587.63	798.68	517.25	824.25	603.40
35	1004.25	1013.10	798.68	961.04	2069.65	682.59
36	1047.12	1242.45	1230.50	961.04	933.84	682.59
37	1047.12	1013.10	510.75	961.04	933.84	682.59
38	391.18	820.92	93.14	490.18	845.44	365.92
39	391.18	699.87	-490.21	490.18	845.44	365.92
40	997.26	699.87	-4418.07	1629.58	1260.28	576.38
41	1394.21	2224.28	-4418.07	2089.40	1467.59	1801.75
42	2047.87	2844.94	350.15	1708.76	1467.59	1801.75
43	1394.21	2844.94	350.15	1708.76	730.87	702.70
44	1261.96	2259.91	350.15	1708.76	730.87	702.70
45	1261.96	2259.91	1525.07	628.84	1165.53	1581.63
46	1261.96	2259.91	1644.54	2318.54	1165.53	1836.11
47	1282.35	813.90	2327.37	1532.86	1448.97	3826.81

	FIRST BRIGADE			SECOND BRIGADE		
WEEK	BN1	BN2	BN3	BN1	BN2	BN3
48	1076.36	644.49	1644.54	1532.86	847.09	3826.81
49	306.36	169.18	580.14	678.83	614.36	1778.06
50	214.36	169.18	488.18	560.87	523.88	954.48
51	87.58	169.18	373.93	457.39	468.00	849.68
52	33.66	701.21	185.83	283.16	523.88	574.33

APPENDIX G
INFLUENTIAL TRAINING EVENTS

Events as described for each unit were determined by taking the daily costs for those training weeks that were greater than one standard deviation away from the unit mean.

First Brigade events are listed in Fig. G.1 with Second Brigade in Fig. G.2.

UNIT	TRAINING WEEK(S)	EVENT(S)	HIGH/LOW COST
1st Bn.	42-48	Start of 4th Quarter FTX-Week 50-52	High
	16-17	ARTEP-Week 17	High
	23-24	Special Training-Week 21-24	Low
	52-53	FTX End of 4th Quarter	Low
	3-5	Special Training-Week 1-4	Low
2nd Bn.	42-47	FTX-Week 42-44 JTX-Week 47-53 Start of 4th Quarter	High
	29-30	FTX-Week 25-26 Start of 2nd Quarter	High
	31-33	Exchange Program-Week 28-32	Low
3rd Bn.	25-32	FTX-Week 35-36 Start of 2nd Quarter	High
	39-40	Division FTX-Week 39-40	Low
	33-34	FTX-Week 35-36	Low

Figure G.1 First Brigade Influential Events.

UNIT	TRAINING WEEK(S)	EVENT(S)	HIGH/LOW COST
1st Bn.	41-49	ARTEP-Week 37-38 ARTEP-week 47-49 Start of 4th Quarter	High -
	15-17	ARTEP-Week 20-22 Start of 2nd Quarter	High
	1-5	ARTEP-Week 1-2 JTX-Week 6-7	Low
2nd Bn.	15-17	ARTEP-Week 20-22 Start of 2nd Quarter	High
	27-30	ARTEP-Week 30-31 Start of 3rd Quarter	High
	1-5	Start of 1st Quarter	Low
	24-25	ARTEP-Week 20-22 End of 2nd Quarter	Low
3rd Bn.	47-49	ARTEP-Week 46-47 End of 4th Quarter Special Training-Week 50-51	High
	21-22	ARTEP-Week 19-20	High
	23-26	End of 2nd Quarter	Low
	2-3	Start of 1st Quarter	Low

Figure G.2 Second Brigade Influential Events.

APPENDIX H

LAG K SAMPLE AUTOCORRELATION COEFFICIENTS

	FIRST BRIGADE			SECOND BRIGADE		
K	BN1	BN2	BN3	BN1	BN2	BN3
1	.733	.689	.694	.638	.644	.707
2	.383	.357	.345	.465	.336	.334
3	.172	.098	.221	.249	.052	.123
4	.137	.010	.018	.167	-.029	.014
5	.206	-.016	-.110	.171	-.070	.001
6	.148	-.056	-.120	.139	-.108	-.010
7	-.015	-.063	-.051	.035	-.217	-.127
8	-.102	-.108	.098	-.097	-.332	-.203
9	-.100	-.137	.075	-.121	-.361	-.233
10	-.052	-.100	-.017	-.143	-.304	-.232
11	.015	-.074	-.033	-.132	-.157	-.198
12	.023	-.093	-.178	-.196	-.076	-.094
13	.007	-.035	-.335	-.182	-.024	-.056
14	-.016	-.100	-.314	-.197	-.006	.022
15	-.026	-.084	-.273	-.171	-.066	.098
16	-.031	-.055	-.235	-.142	.075	.126
17	-.089	.057	-.125	-.124	.038	.085

APPENDIX I

COMPUTER LISTING FOR FIRST BN., FIRST BDE.

```
FILE: I1ALL     SCRIPT    A    NAVAL POSTGRADUATE SCHOOL

REGRESSION ON INITIAL VARIABLES
REGRESS C1 ON 9 PRED C2-C5 C10-C14 RESID IN C60

   46 CASES USED
    6 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      201. + 0.984 X1 -  10.9 X2
   +  96.5 X3 -  107. X4 - 0.357 X5
 . -0.0353 X6 +0.0436 X7 + 0.313 X8
   - 0.253 X 9

                                            ST. DEV.     T-RATIO =
       COLUMN      COEFFICIENT              OF COEF.     COEF/S.D.
       --                201.0               108.8          1.85
X1     LAG 1            0.9842              0.1621          6.07
X2     PRE EX            -10.9               111.4         -0.10
X3     POST EX            96.5               109.4          0.88
X4     ON EX            -106.9               121.9         -0.88
X5     LAG 2           -0.3570              0.2233         -1.60
X6     LAG 3           -0.0353              0.2305         -0.15
X7     LAG 4            0.0436              0.2355          0.19
X8     LAG 5            0.3130              0.2300          1.36
X9     LAG 6           -0.2528              0.1716         -1.47

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 298.1
WITH (  46-10) =  36 DEGREES OF FREEDOM

R-SQUARED = 66.2 PERCENT
R-SQUARED = 57.7 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF           SS        MS=SS/DF
REGRESSION      9      6263017          695891
RESIDUAL       36      3198621           88851
TOTAL          45      9461647

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

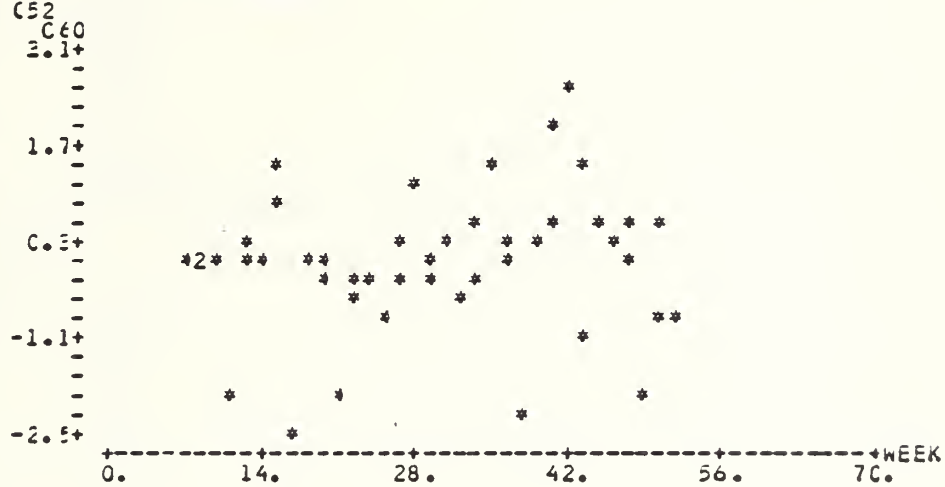
 DUE TO        DF           SS
REGRESSION      9      6263017
LAG 1           1      5129877
PRE EX          1         2184
POST EX         1        71310
ON EX           1        98738
LAG 2           1       509839
LAG 3           1        84974
LAG 4           1       149881
LAG 5           1        23378
LAG 6           1       192844

              X1          Y      PRED. Y     ST.DEV.
ROW        LAG 1   COST/DAY        VALUE     PRED. Y     RESIDUAL       ST.RES.
 17         1140      217.2        820.0       154.0       -602.8        -2.36R
 38         1047      391.2        971.2       127.7       -580.1        -2.15R
 42         1394     2047.9       1380.0       153.7        667.9         2.62R

R DENOTES AN OBS. WITH A LARGE ST. RES.

DURBIN-WATSON STATISTIC = 2.11
```

```
RESIDUAL PLOT OF INITIAL REGRESSION
PLOT C60 VS C52
```



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    6 MISSING OBSERVATIONS
STEPWISE REGRESSION
STEPWISE REGRESS C1 ON C2-C5 C10-C14
STEPWISE REGRESSION OF COST/DAY ON  9 PREDICTORS, WITH N =   46
N(CASES WITH MISSING OBS.) =   6  N(ALL CASES) =   52

     STEP           1        2
CONSTANT        138.5    202.6

LAG 1            0.75     0.99
T-RATIO          7.22     6.99

LAG 2                    -0.34
T-RATIO                  -2.36

S                 314      299
R-SQ            54.22    59.47
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C5.

     STEP           3
CONSTANT        241.7

LAG 1            0.97
T-RATIO          6.73

LAG 2           -0.33
T-RATIO         -2.31

ON EX             -98
T-RATIO         -0.96

S                 299
R-SQ            60.34
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C3.

     STEP           4
CONSTANT        240.9
```

```
T-RATIO          6.63

LAG 2           -0.33
T-RATIO         -2.28

CN EX             -97
T-RATIO         -0.89

PRE EX              3
T-RATIO          0.03

S                 303
R-SQ            60.34
MORE? (YES, NO, SUBCOMMAND, CR HELP)
   --
REMOVE C3.

     STEP           5
CONSTANT        241.7

LAG 1            0.97
T-RATIO          6.73

LAG 2           -0.33
T-RATIO         -2.31

CN EX             -98
T-RATIO         -0.96

PRE EX
T-RATIO

S                 299
R-SQ            60.34
MORE? (YES, NO, SUBCOMMAND, CR HELP)
   --
FORCE C4.

     STEP           6
CONSTANT        241.6

LAG 1            0.94
T-RATIO          6.44

LAG 2           -0.34
T-RATIO         -2.38

CN EX            -103
T-RATIO         -1.00

PRE EX
T-RATIO

POST EX           110
T-RATIO          1.04

S                 299
R-SQ            61.36
MORE? (YES, NO, SUBCOMMAND, CR HELP)
   --
FORCE C11.

     STEP           7
CONSTANT        203.5

LAG 1            0.99
T-RATIO          6.41

LAG 2           -0.49
T-RATIO         -2.36

CN EX            -105
```

```
T-RATIO       -1.02

PRE EX
T-RATIO

POST EX         118
T-RATIO        1.12

LAG 3          0.15
T-RATIO        0.98

S               299
R-SQ          62.27
MORE? (YES, NO, SUBCOMMAND, OR HELP)
  --
N
REGRESSION ON VARIABLE PROVIDED BY STEPWISE
REGRESS C1 ON 4 PRED C2 C4 C5 C10 RESIDS IN C30

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =       255. + 0.946 X1 +  109. X2
    -     100. X3 - 0.338 X4

                                               ST. DEV.     T-RATIO =
          COLUMN       COEFFICIENT             OF COEF.     COEF/S.D.
          --                254.82                82.84          3.08
X1        LAG 1             0.9459               0.1399          6.76
X2        POST EX            109.4                102.3          1.07
X3        ON EX            -100.36                95.43         -1.05
X4        LAG 2            -0.3377               0.1377         -2.45

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 290.0
WITH (  50- 5) =  45 DEGREES OF FREEDOM

R-SQUARED = 63.0 PERCENT
R-SQUARED = 59.7 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF             SS          MS=SS/DF
REGRESSION     4        6441926           1610481
RESIDUAL      45        3783894             84087
TOTAL         49       10225820

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO       DF             SS
REGRESSION     4        6441926
LAG 1          1        5739509
POST EX        1          60146
ON EX          1         136818
LAG 2          1         505458

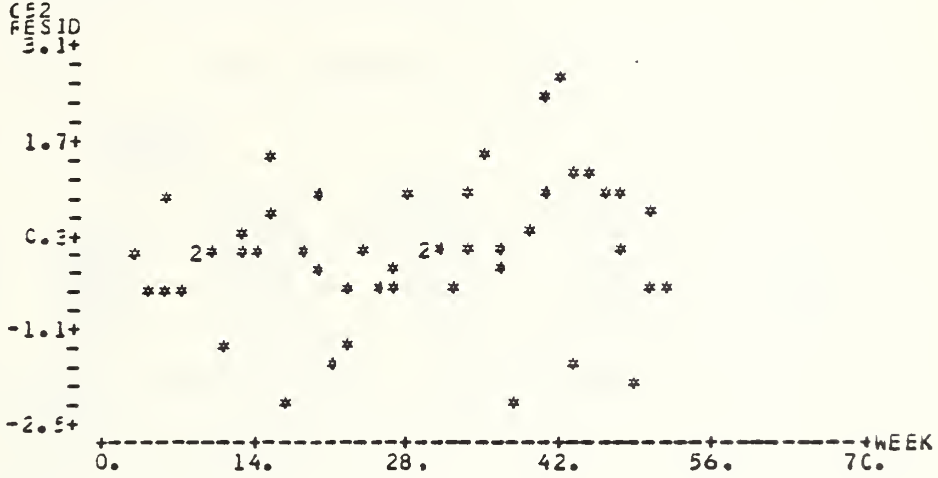
                X1          Y      PRED. Y     ST.DEV.
ROW          LAG 1   COST/DAY      VALUE      PRED. Y     RESIDUAL       ST.RES.
 17          1140      217.2       847.8       109.3       -630.5        -2.35R
 18           217      217.2       184.6       155.8         32.6         0.13 X
 38          1047      391.2      1001.0        88.1       -609.8        -2.21R
 39           391      391.2       280.2       134.4        111.0         0.43 X
 40           391      997.3       392.4        84.9        604.9         2.18R
 42          1394     2047.9      1346.1       101.4        701.7         2.58R
 43          2048     1394.2      1830.4       143.5       -436.1        -1.73 X
 44          1394     1262.0       991.3       150.0        270.6         1.09 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.
```

```
FILE: I1ALL     SCRIPT   A   NAVAL POSTGRADUATE SCHOOL

DURBIN-WATSON STATISTIC = 1.96

RESIDUALS ON REGRESSION OF SELECTED VARIABLES
PLOT C30 VS C52
```



```
   2 MISSING OBSERVATIONS

INCLUSION OF FOURTH QUARTER VARIABLE
REGRESS C1 ON 5 PRED C2 C4 C5 C9 C10 RESID C31

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      284. + 0.887 X1 +  130. X2
    -    129. X3 +  215. X4 - 0.405 X5

                                          ST. DEV.     T-RATIO =
          COLUMN        COEFFICIENT       OF COEF.     COEF/S.D.
          --              283.75           81.44          3.48
X1        LAG 1           0.8870          0.1385          6.40
X2        POST EX         129.72           99.52          1.30
X3        ON EX          -129.10           93.45         -1.38
X4        FOURTH           215.4           107.0          2.01
X5        LAG 2          -0.4053          0.1375         -2.95

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 280.6
WITH (   50-  6) =   44 DEGREES OF FREEDOM

R-SQUARED = 66.1 PERCENT
R-SQUARED = 62.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF           SS        MS=SS/DF
REGRESSION      5      6761109         1352221
RESIDUAL       44      3464705           78743
TOTAL          49     10225820

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF           SS
REGRESSION      5      6761109
LAG 1           1      5739509
POST EX         1        60146
```

```
FILE: IIALL    SCRIPT   A   NAVAL POSTGRADUATE SCHOOL

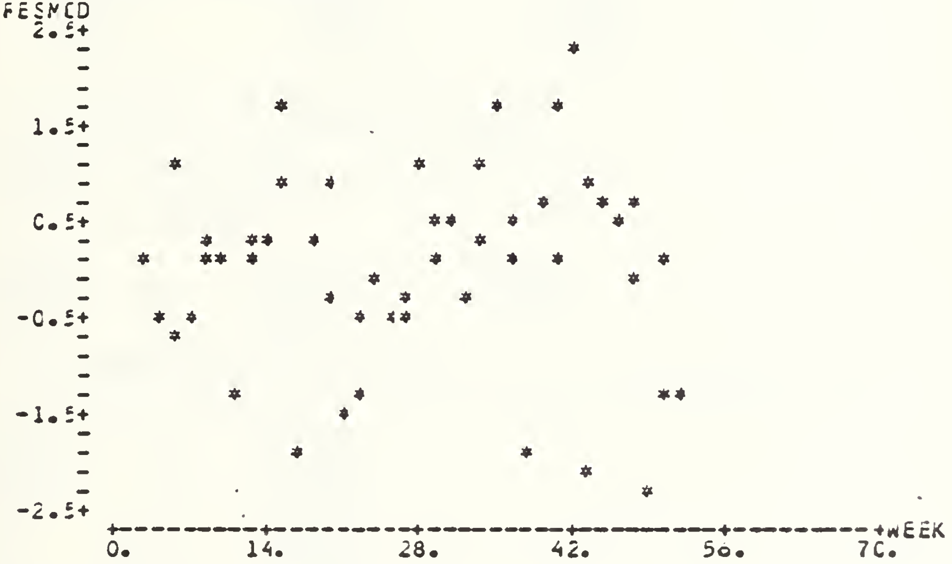
ON EX          1         136818
FOURTH         1         140129
LAG 2          1         684512

              X1           Y       PRED. Y     ST.DEV.
ROW        LAG 1    COST/DAY       VALUE     PRED. Y    RESIDUAL      ST.RES.
 18          217       217.2       144.1       152.1        73.1       0.31 X
 41          997      1394.2      1354.9       142.1        39.3       0.16 X
 42         1394      2047.9      1461.4       113.6       586.5       2.29R
 43         2048      1394.2      1880.3       141.1      -486.1      -2.00RX
 44         1394      1262.0      1035.6       146.8       226.4       0.95 X
 49         1076       306.4       934.2        94.5      -627.8      -2.38R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 2.00

RESIDUALS OF MODIFICATION REGRESSION
PLOT C31 VS C52
```



```
  2 MISSING OBSERVATIONS
```

APPENDIX J

COMPUTER LISTING FOR SECOND BN., FIRST BDE.

```
FILE: I2ALL     SCRIPT    A    NAVAL POSTGRADUATE SCHOOL

REGRESSION ON INITIAL VARIABLES
REGRESS C1 ON 9 PRED C2-C5 C10-C14 RESID IN C60

   46 CASES USED
    6 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     378. + 0.559 X1 -  247. X2
    +  537. X3 +  124. X4 -0.0313 X5
    - 0.260 X6 + 0.156 X7 -0.0105 X8
    -0.0694 X 9

                                            ST. DEV.     T-RATIO =
       COLUMN      COEFFICIENT              OF COEF.     COEF/S.D.
       --                377.8               242.2          1.56
X1     LAG 1            0.5588              0.1699          3.29
X2     PRE  EX          -247.2               191.4         -1.29
X3     POST EX           537.0               205.5          2.61
X4     ON  EX            124.2               191.2          0.65
X5     LAG 2           -0.0313              0.1930         -0.16
X6     LAG 3           -0.2600              0.1918         -1.36
X7     LAG 4            0.1557              0.1901          0.82
X8     LAG 5           -0.0105              0.1897         -0.06
X9     LAG 6           -0.0694              0.1714         -0.40

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 529.1
WITH (  46-10) =  36 DEGREES OF FREEDOM

R-SQUARED = 62.5 PERCENT
R-SQUARED = 53.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF            SS       MS=SS/DF
REGRESSION     9      16817121       1868567
RESIDUAL      36      10078601        279961
TOTAL         45      26895723

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

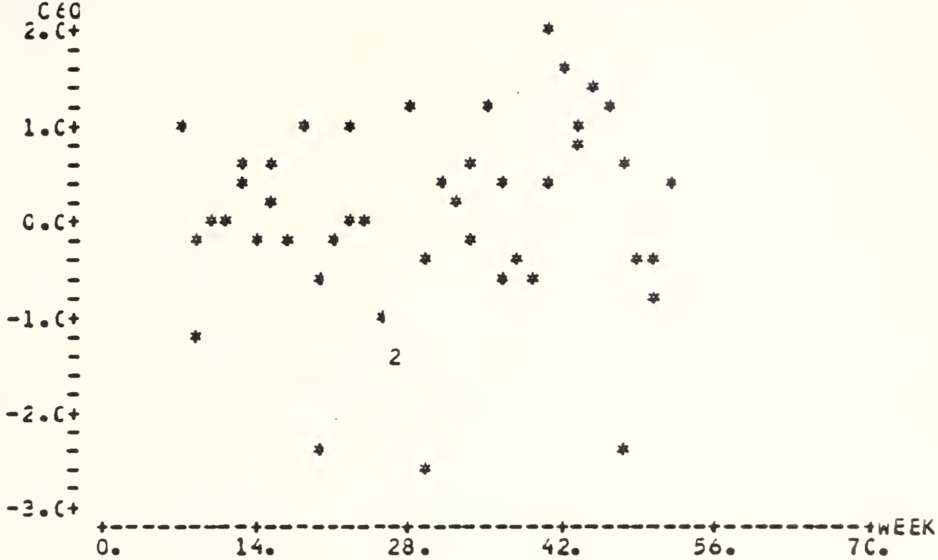
 DUE TO       DF            SS
REGRESSION     9      16817121
LAG 1          1      12966451
PRE EX         1        591768
POST EX        1       2109012
ON EX          1        178151
LAG 2          1        406993
LAG 3          1        302686
LAG 4          1        187551
LAG 5          1         28640
LAG 6          1         45871

            X1            Y      PRED. Y      ST.DEV.
ROW      LAG 1     COST/DAY        VALUE      PRED. Y      RESIDUAL        ST.RES.
 19       1800        557.1       1668.4        216.1       -1111.2         -2.30R
 30       1716       -150.3       1067.9        272.8       -1218.2         -2.69R
 31       -150       -150.3       -307.4        357.5         157.1          0.40 X
 47       2260        813.9       1902.3        266.9       -1088.4         -2.45R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.74
```

```
RESIDUALS FROM INITIAL REGRESSION
PLOT C60 VS C52
```



```
   6 MISSING OBSERVATIONS

STEPWISE REGRESSION
STEPWISE REGRESS C1 ON C2-C5 C10-C14
STEPWISE REGRESSION OFCOST/DAY ON  9 PREDICTORS, WITH N =    46
N(CASES WITH MISSING OBS.) =    6  N(ALL CASES) =    52

    STEP          1         2
CONSTANT      264.9     227.2

LAG 1          0.69      0.52
T-RATIO        6.40      4.31

POST EX                   508
T-RATIO                  2.72

S               563       526
R-SQ          46.21     55.82
MORE? (YES, NO, SUBCOMMAND, CR HELP)
--
FORCE C10.

    STEP          3
CONSTANT      282.5

LAG 1          0.66
T-RATIO        4.26

POST EX         501
T-RATIO        2.71

LAG 2         -0.20
T-RATIO       -1.43

S               519
R-SQ          57.88
MORE? (YES, NO, SUBCOMMAND, CR HELP)
```

```
--
FORCE C5
* SUBCOMMAND DOES NOT END IN . OR ; (; ASSUMED)
--
FORCE C5.

    STEP            4
CONSTANT        209.9

LAG 1            0.63
T-RATIO          4.00

POST EX           542
T-RATIO          2.88

LAG 2           -0.18
T-RATIO         -1.30

ON EX             169
T-RATIO          1.07

S                 518
R-SQ            59.02
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C3.

    STEP            5
CONSTANT        329.9

LAG 1            0.59
T-RATIO          3.69

POST EX           535
T-RATIO          2.86

LAG 2           -0.17
T-RATIO         -1.24

ON EX             114
T-RATIO          0.69

PRE EX           -203
T-RATIO         -1.19

S                 516
R-SQ            60.43
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
REMOVE C5.

    STEP            6
CONSTANT        394.6

LAG 1            0.60
T-RATIO          3.82

POST EX           509
T-RATIO          2.79

LAG 2           -0.18
T-RATIO         -1.32

ON EX
T-RATIO

PRE EX           -236
T-RATIO         -1.46

S                 513
R-SQ            59.95
MORE? (YES, NO, SUBCOMMAND, OR HELP)
```

```
FILE: I2ALL    SCRIPT   A   NAVAL POSTGRADUATE SCHOOL


  --
N


REGRESSION ON STEPWISE SELECTED VARIABLES
REGRESS C1 ON 4 PRED C2 C4 C5 C10 RESIDS IN C30

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      269. + 0.699 X1 +  436. X2
    +  80.8 X3 - 0.230 X4

                                              ST. DEV.     T-RATIO =
       COLUMN      COEFFICIENT                OF COEF.     COEF/S.D.
       --                268.8                  135.0           1.99
X1     LAG 1            0.6989                 0.1483           4.71
X2     POST EX           436.1                  177.4           2.46
X3     ON EX              80.8                  150.2           0.54
X4     LAG 2           -0.2296                 0.1370          -1.68

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 519.6
WITH (  50- 5) =  45 DEGREES OF FREEDOM

R-SQUARED = 56.2 PERCENT
R-SQUARED = 52.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF           SS       MS=SS/DF
REGRESSION     4     15578823        3894706
RESIDUAL      45     12149200         269982
TOTAL         49     27728004

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

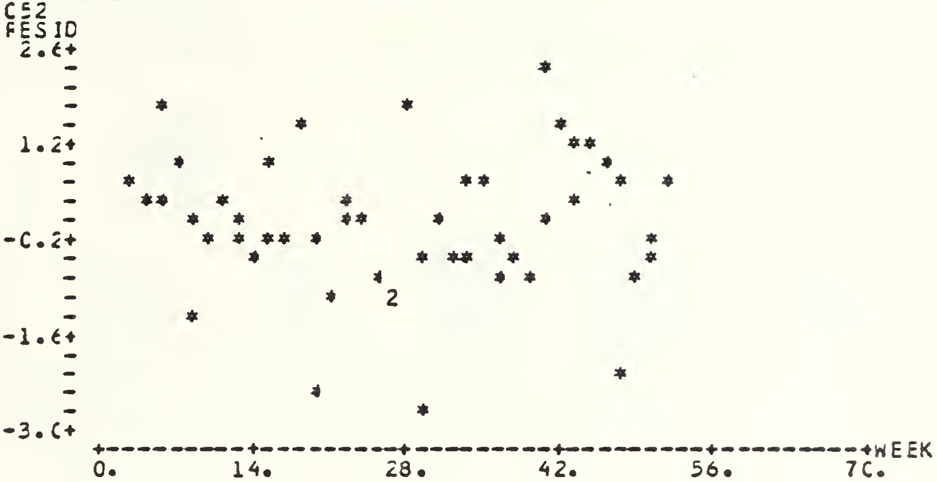
 DUE TO       DF           SS
REGRESSION     4     15578823
LAG 1          1     13202247
POST EX        1      1512087
ON EX          1       106952
LAG 2          1       757535

            X1          Y     PRED. Y     ST.DEV.
ROW      LAG 1   COST/DAY       VALUE     PRED. Y    RESIDUAL       ST.RES.
 19       1800      557.1      1769.0       172.4     -1211.8        -2.47R
 30       1716     -150.3      1155.1       181.1     -1305.4        -2.68R
 31       -150     -150.3      -149.5       266.5        -0.8        -0.00 X
 41        700     2224.3      1114.2       173.3      1110.1         2.27R
 44       2845     2259.9      2040.1       232.9       219.8         0.47 X
 47       2260      813.9      1846.3       189.9     -1032.4        -2.13R
 48        814      644.5       399.6       238.1       244.9         0.53 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.90
```

```
RESIDUALS OF SELECTED VARIABLE REGRESSION
PLOT C30 VS C52
```



```
   2 MISSING OBSERVATIONS

REGRESSION WITH FOURTH QUARTER VARIALBE ADDED
REGRESS C1 ON 5 PRED C2 C4 C5 C9 C10 RESIDS IN C32

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      334. + 0.664 X1 +  428. X2
    -    74.7 X3 +  414. X4 - 0.315 X5

                                              ST. DEV.     T-RATIO =
         COLUMN      COEFFICIENT              OF COEF.     COEF/S.D.
         --                333.9                135.0           2.47
X1       LAG 1            0.6643               0.1448           4.59
X2       POST EX           427.6                172.0           2.49
X3       ON EX             -74.7                165.6          -0.45
X4       FOURTH            413.5                210.0           1.97
X5       LAG 2           -0.3153               0.1398          -2.25

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 503.7
WITH (  50- 6) =  44 DEGREES OF FREEDOM

R-SQUARED = 59.7 PERCENT
R-SQUARED = 55.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE
```

```
 DUE TO        DF            SS          MS=SS/DF
REGRESSION     5       16562957          3312590
RESIDUAL      44       11165056           253751
TOTAL         49       27728004

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

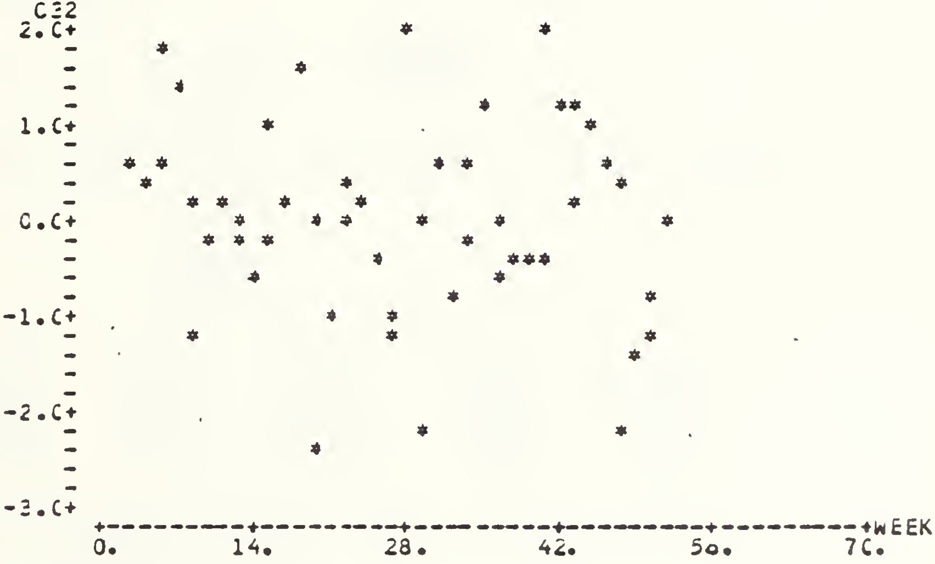
 DUE TO        DF            SS
REGRESSION     5       16562957
LAG 1          1       13202247
POST EX        1        1512087
ON EX          1         106952
FOURTH         1         451352
LAG 2          1        1290317

               X1            Y      PRED. Y     ST.DEV.
ROW        LAG 1     COST/DAY       VALUE     PRED. Y     RESIDUAL       ST.RES.
 19         1800        557.1      1690.8       171.8      -1133.7       -2.39R
 30         1716       -150.3       858.3       231.4      -1008.6       -2.25R
 31         -150       -150.3      -381.8       284.0        231.5        0.56 X
 47         2260        813.9      1889.1       185.4      -1075.2       -2.30R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 2.04


RESIDUALS AFTER MODIFICATION
PLOT C32 VS C52
```



```
   2 MISSING OBSERVATIONS

REGRESSION WITH ON-EX REMOVED
REGRESS C1 ON 4 PRED C2 C10 C4 C9 RESIDS IN C33

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
```

```
FILE: 12ALL     SCRIPT    A    NAVAL POSTGRADUATE SCHOOL

Y =      302. + 0.662 X1 - 0.303 X2
    +    436. X3 +  368. X4

                                         ST. DEV.     T-RATIO =
        COLUMN       COEFFICIENT         OF COEF.     COEF/S.D.
        --               302.1            114.2          2.65
X1      LAG 1           0.6623           0.1435          4.62
X2      LAG 2          -0.3030           0.1359         -2.23
X3      POST EX          436.2            169.4          2.57
X4      FOURTH           368.4            183.0          2.01

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 499.3
WITH (   50-  5) =  45 DEGREES OF FREEDOM

R-SQUARED = 59.5 PERCENT
R-SQUARED = 56.0 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF            SS         MS=SS/DF
REGRESSION      4      16511325          4127829
RESIDUAL       45      11216688           249260
TOTAL          49      27728004

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF            SS
REGRESSION      4      16511325
LAG 1           1      13202247
LAG 2           1        726062
POST EX         1       1572426
FOURTH          1       1010586

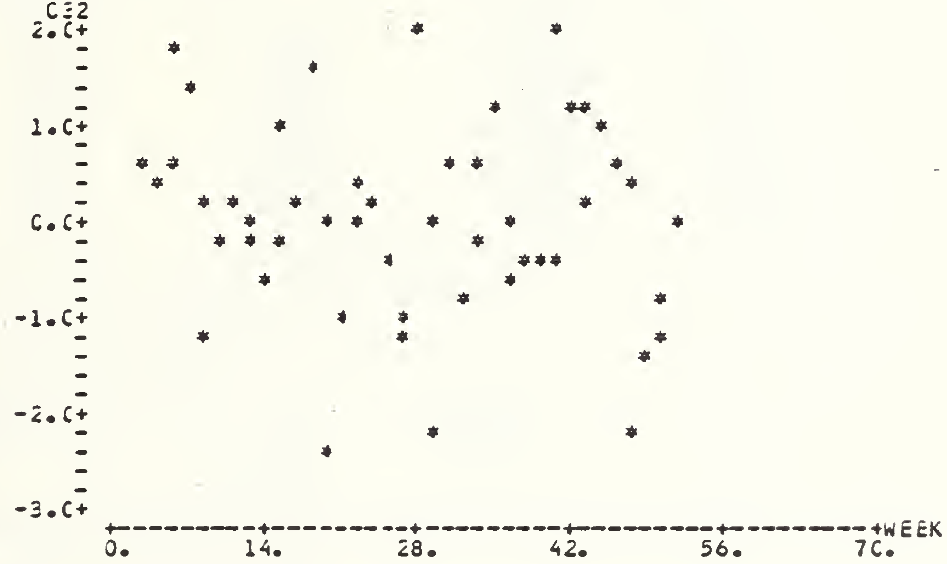
              X1            Y      PRED. Y     ST.DEV.
ROW        LAG 1     COST/DAY       VALUE     PRED. Y     RESIDUAL        ST.RES.
 19         1800        557.1      1674.4       166.4      -1117.3        -2.37R
 30         1716       -150.3       918.7       186.9      -1069.1        -2.31R
 31         -150       -150.3      -317.6       243.6        167.3         0.38 X
 42         2224       2844.9      2367.8       238.5        477.1         1.09 X
 47         2260        813.9      1918.6       171.9      -1104.7        -2.36R
 48          814        644.5       524.7       228.5        119.8         0.27 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 2.00
```

```
FILE: I2ALL     SCRIPT   A   NAVAL POSTGRADUATE SCHOOL


RESIDUALS AFTER MODIFICATION
PLOT C32 VS C52
```



```
2 MISSING OBSERVATIONS
```

APPENDIX K

COMPUTER LISTING FOR THIRD BN., FIRST BDE.

```
FILE: I3ALL     SCRIPT    A    NAVAL PCSTGRADUATE SCHOCL

RETRIEVE 'BC1BN3'
REGRESSICN CN INITIAL VARIABLES
REGRESS C1 CN 9 PRED C2-C5 C10-C14 RESID IN C60

   46 CASES USED
    6 CASES CCNTAINED MISSING VALUES

THE REGRESSICN EQUATION IS
Y =      720. +  1.10 X1 -   234. X2
    -   257. X3 -   785. X4 - 0.907 X5
    + 0.855 X6 - 0.725 X7 + 0.472 X8
    - 0.249 X 9

                                            ST. DEV.     T-RATIO =
        CCLUMN      COEFFICIENT             CF CCEF.     COEF/S.D.
        --               719.9               325.2          2.21
X1      LAG 1           1.0978              0.1581          6.94
X2      PRE EX          -234.1               302.1         -0.78
X3      PCST EX         -257.1               346.2         -0.74
X4      CN EX           -785.0               364.8         -2.15
X5      LAG 2          -0.9074              0.2290         -3.96
X6      LAG 3           0.8551              0.2408          3.55
X7      LAG 4          -0.7245              0.2398         -3.02
X8      LAG 5           0.4721              0.2286          2.07
X9      LAG 6          -0.2495              0.1562         -1.60

THE ST. DEV. CF Y ABOUT REGRESSICN LINE IS
S = 870.1
WITH (   46-10) =  36 DEGREES OF FREEDCM

R-SCUARED = 68.8 PERCENT
R-SCUARED = 61.0 PERCENT, ADJUSTED FCR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF           SS       MS=SS/DF
REGRESSICN     9     60153369        6683707
RESIDUAL      36     27251766         756993
TCTAL         45     87405138

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

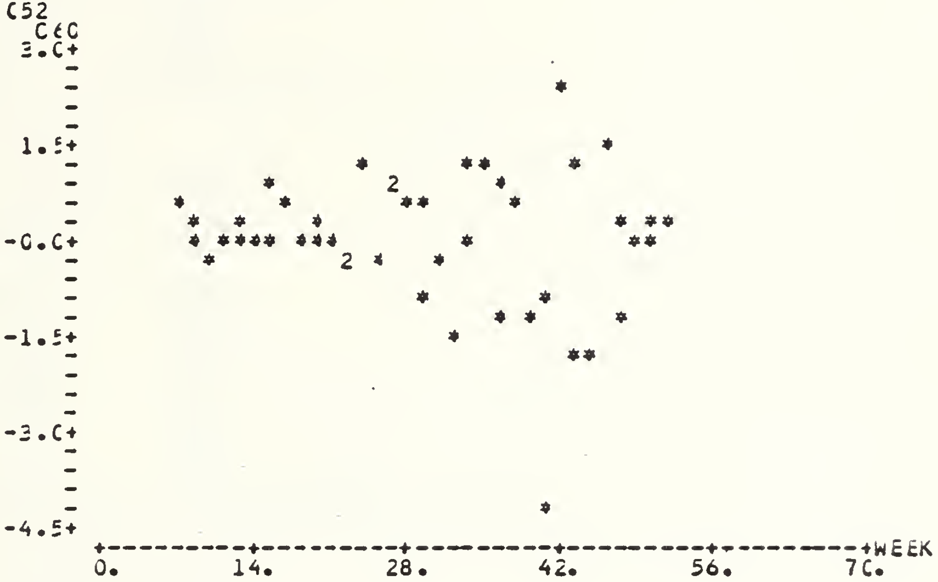
 DUE TO       DF           SS
REGRESSICN     9     60153369
LAG 1          1     42440137
PRE EX         1       366335
PCST EX        1        13926
CN EX          1      3882694
LAG 2          1      3584675
LAG 3          1      2248478
LAG 4          1      4377725
LAG 5          1      1308064
LAG 6          1      1931377

             X1          Y      PREC. Y     ST.DEV.
RCW       LAG 1   COST/DAY       VALUE     PRED. Y    RESIDUAL     ST.RES.
 40        -490      -4418        -965         332       -3453      -4.29R
 41       -4418      -4418       -3851         663        -567      -1.01 X
 42       -4418        350        -931         671        1261       2.31RX
 43         350        350        1350         699       -1000      -1.93 X
 44         350        350        -302         706         652       1.28 X
 45         350       1525        2323         726        -798      -1.66 X
 46        1525       1645         904         714         740       1.49 X
 47        1645       2327        2221         745         107       0.24 X

R DENOTES AN CBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSCN STATISTIC = 1.93
```

```
RESIDUALS AFTER INITIAL REGRESSION
PLOT C60 VS C52
```



```
   6 MISSING OBSERVATIONS
STEPWISE REGRESSION
STEPWISE REGRESS C1 ON C2-C5 C10-C14
STEPWISE REGRESSION OFCOST/DAY ON  9 PREDICTORS, WITH N =    46
N(CASES WITH MISSING OBS.) =    6  N(ALL CASES) =    52

    STEP          1
CONSTANT      234.2

LAG 1          0.70
T-RATIO        6.44

S              1011
R-SQ          48.56
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C10.

    STEP          2
CONSTANT      301.8

LAG 1          0.88
T-RATIO        5.99

LAG 2         -0.26
T-RATIO       -1.79

S               987
R-SQ          52.11
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C5.

    STEP          3
```

```
CONSTANT     445.9

LAG 1         0.86
T-RATIO       5.92

LAG 2        -0.27
T-RATIO      -1.87

ON EX         -567
T-RATIO      -1.68

S              967
R-SQ         55.11
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C3.

    STEP         4
CONSTANT     567.7

LAG 1         0.86
T-RATIO       5.93

LAG 2        -0.26
T-RATIO      -1.76

ON EX         -661
T-RATIO      -1.87

PRE EX        -300
T-RATIO      -0.94

S              968
R-SQ         56.06
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
REMOVE C3.

    STEP         5
CONSTANT     445.9

LAG 1         0.86
T-RATIO       5.92

LAG 2        -0.27
T-RATIO      -1.87

ON EX         -567
T-RATIO      -1.68

PRE EX
T-RATIO

S              967
R-SQ         55.11
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
N
REGRESSION ON SELECTED VARIABLES
REGRESS C1 ON 3 PRED C2 C5 C10 RESID IN C30

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     450. + 0.858 X1 -   554. X2
    - 0.271 X3

                                            ST. DEV.     T-RATIO =
       COLUMN       COEFFICIENT              OF COEF.     COEF/S.D.
        --                450.3                178.7          2.52
X1     LAG 1             0.8575               0.1386          6.19
```

```
FILE: I3ALL     SCRIPT    A    NAVAL POSTGRADUATE SCHOOL

X2      CN EX            -553.9            320.4         -1.73
X3      LAG 2           -0.2711           0.1380         -1.96

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 926.2
WITH (  50- 4) =  46 DEGREES OF FREEDOM

R-SQUARED = 54.9 PERCENT
R-SQUARED = 52.0 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF            SS        MS=SS/DF
REGRESSION      3      48114395        16038131
RESIDUAL       46      39464149          857916
TOTAL          49      87578592

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF            SS
REGRESSION      3      48114395
LAG 1           1      42365293
CN EX           1       2437339
LAG 2           1       3311779

             X1          Y      PRED. Y    ST.DEV.
ROW       LAG 1   COST/DAY       VALUE    PRED. Y     RESIDUAL       ST.RES.
 40        -490      -4418        -549        295        -3869       -4.41R
 41       -4418      -4418       -3205        641        -1213       -1.81 X
 42       -4418        350       -2141        600         2491        3.53RX
 43         350        350        1948        698        -1598       -2.62RX

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.95

RESIDUALS OF SELECTED VARIABLE REGRESSION
PLOT C30 VS C52
              C30
             4.0+
                -                               *
                -
                -
                -
             2.0+
                -                    *    *
                -                  *
                -            **       *           * * *
                -   *  **           ** *    *         *
             0.0+    *    *2** *2*2     *  *       *   *
                -     2 **                *  **  *  *
                -                      *    *        *
                -
                -
            -2.0+                        *     *
                -
                -                                *
                -
                -
            -4.0+
                -                              *
                -
                -
                -
            -6.0+
                  +---------+---------+---------+---------+---------+---------+WEEK
                  0.       14.       28.       42.       56.       70.
```

```
FILE: I3ALL     SCRIPT   A   NAVAL POSTGRADUATE SCHOOL

   2 MISSING OBSERVATIONS

REGRESSION AFTER ADDITION OF FOURTH QUARTER EFFECT
REGRESS C1 ON 4 PRED C2 C5 C9 C10 RESID IN C31

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      578. + 0.835 X1 -  528. X2
   -     359. X3 - 0.298 X4

                                              ST. DEV.     T-RATIO =
        COLUMN       COEFFICIENT              OF COEF.     COEF/S.D.
        --                578.0                 212.3         2.72
X1      LAG 1             0.8354               0.1397         5.98
X2      ON EX            -528.4                 320.4        -1.65
X3      FOURTH           -358.9                 324.4        -1.11
X4      LAG 2            -0.2981               0.1398        -2.13

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 924.0
WITH (  50-  5) = 45 DEGREES OF FREEDOM

R-SQUARED = 56.1 PERCENT
R-SQUARED = 52.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF             SS        MS=SS/DF
REGRESSION     4       49159030        12289762
RESIDUAL      45       38419513          853767
TOTAL         49       87578592

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

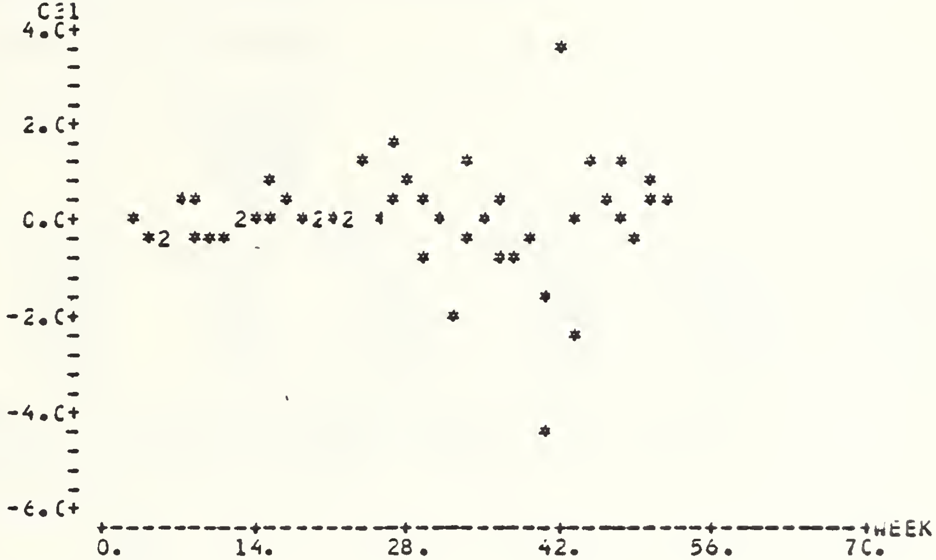
 DUE TO       DF             SS
REGRESSION     4       49159030
LAG 1          1       42365293
ON EX          1        2437339
FOURTH         1         473759
LAG 2          1        3882661

              X1          Y      PRED. Y      ST.DEV.
ROW        LAG 1   COST/DAY       VALUE       PRED. Y     RESIDUAL      ST.RES.
 40         -490      -4418        -747          344        -3672       -4.28R
 41        -4418      -4418       -3326          649        -1092       -1.66 X
 42        -4418        350       -2155          599         2505        3.56RX
 43          350        350        1829          704        -1479       -2.47RX

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.88
```

```
RESIDUALS AFTER INCLUSION OF FOURTH QUARTER VARIABLE
PLOT C31 VS C32
```



```
   2 MISSING OBSERVATIONS

ADDITION OF LAG 3 VARIABLE
REGRESS C1 ON 5 PRED C2 C10 C11 C5 C9 RESIDS IN C33

   49 CASES USED
    3 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     477. + 0.905 X1 - 0.507 X2
   + 0.248 X3 -  646. X4 -  224. X5

                                           ST. DEV.    T-RATIO =
         COLUMN      COEFFICIENT           OF COEF.    COEF/S.D.
         --                477.3             221.9          2.15
X1       LAG 1            0.9049            0.1446          6.26
X2       LAG 2           -0.5066            0.1870         -2.71
X3       LAG 3            0.2481            0.1486          1.67
X4       ON EX            -645.6             326.5         -1.98
X5       FOURTH           -224.3             332.6         -0.67

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 915.9
WITH (  49-  6) =  43 DEGREES OF FREEDOM

R-SQUARED = 58.8 PERCENT
R-SQUARED = 54.0 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE
```

```
FILE: I3ALL     SCRIPT   A   NAVAL POSTGRADUATE SCHOOL


 DUE TO        DF          SS        MS=SS/DF
REGRESSION      5    51453361        10290670
RESIDUAL       43    36067924          838789
TOTAL          48    87521314

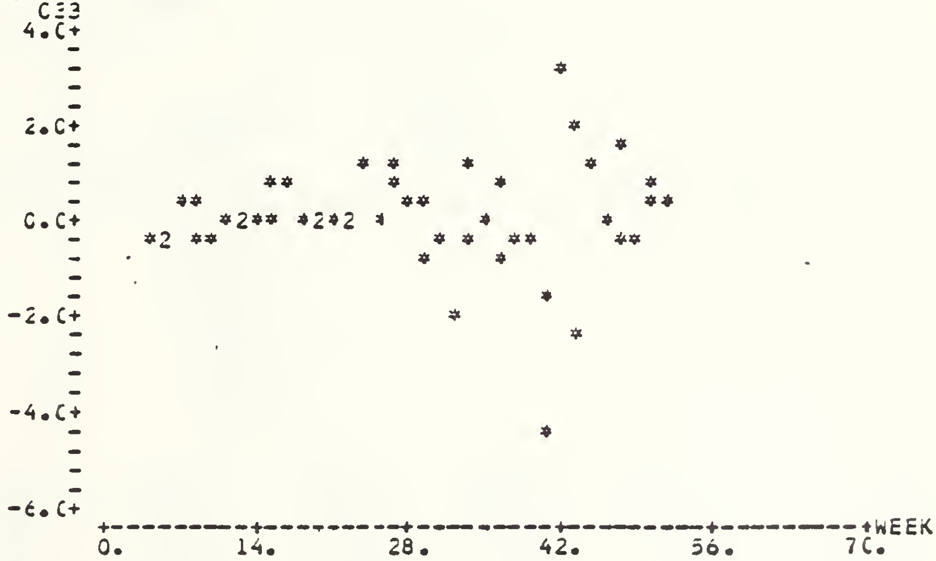
FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF          SS
REGRESSION      5    51453361
LAG 1           1    42470388
LAG 2           1     3140181
LAG 3           1     1880805
ON EX           1     3580482
FOURTH          1      381505

               X1           Y     PRED. Y     ST.DEV.
ROW         LAG 1    COST/DAY       VALUE     PRED. Y     RESIDUAL       ST.RES.
 32          1285        -584        1288         176        -1873       -2.06R
 40          -490       -4418        -757         342        -3661       -4.31R
 41         -4418       -4418       -3473         649         -945       -1.46 X
 42         -4418         350       -1628         676         1978        3.20RX
 43           350         350        1712         702        -1362       -2.32RX
 44           350         350        -704         719         1054        1.86 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.85
--
PLOT C33 VS C52
```



```
  3 MISSING OBSERVATIONS
```

APPENDIX L

COMPUTER LISTING FOR FIRST BN., SECOND BDE.

```
FILE: III1ALL   SCRIPT   A   NAVAL POSTGRADUATE SCHOOL

RETRIEVE 'BC2BN1'
REGRESSION ON INITIAL VARIABLES
REGRESS C1 ON 9 PRED C2-C5 C10-C14 RESID IN C60

   46 CASES USED
    6 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     277. + 0.656 X1 -  188. X2
     +  36.6 X3 +  205. X4 + 0.206 X5
     - 0.144 X6 +0.0266  X7 +0.0471 X8
     - 0.142 X 9

                                             ST. DEV.     T-RATIO =
          COLUMN      COEFFICIENT            OF COEF.     COEF/S.D.
          --                276.7              179.4          1.54
X1        LAG 1            0.6562             0.1644          3.99
X2        PRE EX           -187.7              153.7         -1.22
X3        POST EX            36.6              130.7          0.28
X4        ON EX             205.0              140.9          1.45
X5        LAG 2            0.2056             0.1850          1.11
X6        LAG 3           -0.1438             0.1864         -0.77
X7        LAG 4            0.0266             0.1858          0.14
X8        LAG 5            0.0471             0.1890          0.25
X9        LAG 6           -0.1418             0.1768         -0.80

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 426.1
WITH (  46-10) =  36 DEGREES OF FREEDOM

R-SQUARED = 48.4 PERCENT
R-SQUARED = 35.5 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF           SS       MS=SS/DF
REGRESSION     9      6121538        680171
RESIDUAL      36      6535666        181546
TOTAL         45     12657213

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

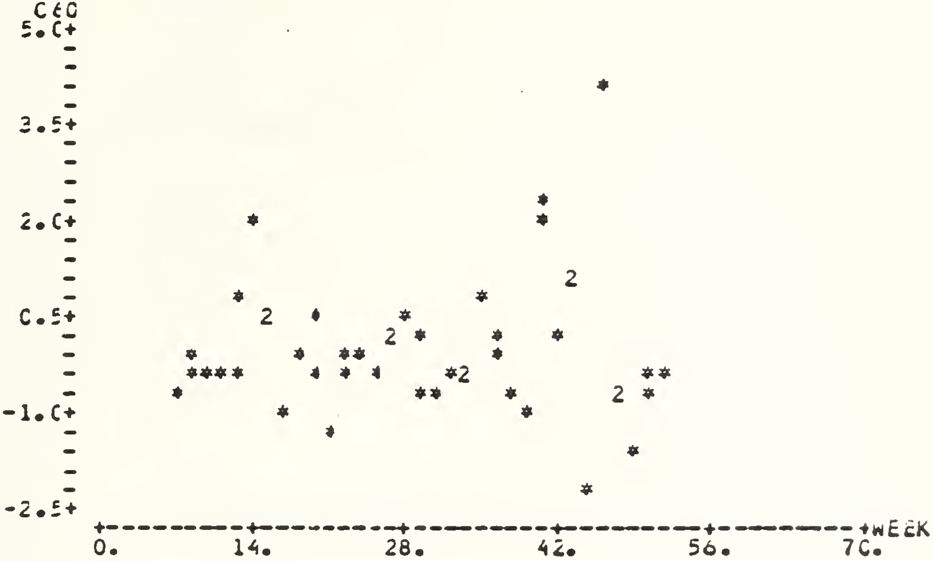
 DUE TO       DF           SS
REGRESSION     9      6121538
LAG 1          1      5226309
PRE EX         1       157175
POST EX        1           73
ON EX          1       377976
LAG 2          1       104230
LAG 3          1       137404
LAG 4          1          557
LAG 5          1         1061
LAG 6          1       116754

              X1          Y      PRED. Y     ST.DEV.
ROW        LAG 1   COST/DAY      VALUE      PRED. Y     RESIDUAL       ST.RES.
 40          490     1629.6      800.1        182.2        829.5         2.15R
 41         1630     2089.4     1347.6        231.0        741.8         2.07R
 45         1709      628.8     1378.8        246.7       -749.9        -2.16R
 46          629     2318.5      912.8        244.7       1405.7         4.03R
 47         2319     1532.9     1716.5        337.9       -183.7        -0.71 X
 48         1533     1532.9     1757.5        311.4       -224.7        -0.77 X
 49         1533      678.8     1156.0        309.4       -477.2        -1.63 X
 50          679      560.9      702.7        305.3       -141.8        -0.48 X
 51          561      457.4      661.3        294.6       -204.0        -0.66 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 2.02
```

```
RESIDUALS OF INITIAL REGRESSION
PLOT C60 VS C52
```



```
   6 MISSING OBSERVATIONS


STEPWISE REGRESSION
STEPWISE REGRESS C1 ON C2-C5 C10-C14
STEPWISE REGRESSION OF COST/DAY ON  9 PREDICTORS, WITH N =    46
N(CASES WITH MISSING OBS.) =    6   N(ALL CASES) =    52

     STEP          1
CONSTANT       278.2

LAG 1           0.65
T-RATIO         5.56

S                411
R-SQ           41.29
MORE? (YES, NO, SUBCOMMAND, OR HELP)
 --
FORCE C5.

     STEP          2
CONSTANT       197.2

LAG 1           0.66
T-RATIO         5.74

ON EX            194
T-RATIO         1.52

S                405
R-SQ           44.27
MORE? (YES, NO, SUBCOMMAND, OR HELP)
 --
FORCE C10.
```

```
     STEP          3
CONSTANT       164.6

LAG 1           0.60
T-RATIO         3.99

CN EX            196
T-RATIO         1.52

LAG 2           0.10
T-RATIO         0.68

S                408
R-SQ           44.88
MORE? (YES, NO, SUBCOMMAND, OR HELP)
 --
FORCE C3.

     STEP          4
CONSTANT       185.5

LAG 1           0.61
T-RATIO         4.08

CN EX            196
T-RATIO         1.52

LAG 2           0.12
T-RATIO         0.80

PRE EX          -133
T-RATIO        -1.06

S                407
R-SQ           46.34
MORE? (YES, NO, SUBCOMMAND, OR HELP)
 --
REMOVE C10.

     STEP          5
CONSTANT       221.6

LAG 1           0.69
T-RATIO         5.81

CN EX            193
T-RATIO         1.51

LAG 2
T-RATIO

PRE EX          -121
T-RATIO        -0.97

S                405
R-SQ           45.51
MORE? (YES, NO, SUBCOMMAND, OR HELP)
 --
FORCE C4.

     STEP          6
CONSTANT       215.6

LAG 1           0.69
T-RATIO         5.74

CN EX            194
T-RATIO         1.50

LAG 2
T-RATIO
```

```
PRE EX        -121
T-RATIO      -0.96

FCST EX         12
T-RATIO       0.10

S              410
R-SQ         45.52
MORE? (YES, NO, SUBCOMMAND, OR HELP)
  --
REMOVE C4,C10.

   STEP          7
CONSTANT     221.6

LAG 1         0.69
T-RATIO       5.81

ON EX          193
T-RATIO       1.91

LAG 2
T-RATIO

PRE EX        -121
T-RATIO      -0.97

FCST EX
T-RATIO

S              405
R-SQ         45.51
MORE? (YES, NO, SUBCOMMAND, OR HELP)
  --
N


REGRESSION ON SELECTED VARIABLES
REGRESS C1 ON 4 PRED C2 C3 C5 C10 RESID IN C30

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     193. + 0.582 X1 -  125. X2
    +   214. X3 + 0.154 X4

                                            ST. DEV.      T-RATIO =
       COLUMN      COEFFICIENT              OF COEF.      COEF/S.D.
       --               192.9                  123.6           1.56
X1     LAG 1           0.5821                 0.1426           4.08
X2     PRE EX          -124.7                  121.9          -1.02
X3     ON EX            213.9                  119.6           1.79
X4     LAG 2           0.1538                 0.1429           1.08

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 399.0
WITH (   50-  5) =  45 DEGREES OF FREEDOM

R-SQUARED = 47.0 PERCENT
R-SQUARED = 42.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF          SS        MS=SS/DF
REGRESSION      4     6365793         1591446
RESIDUAL       45     7164465          159210
TOTAL          49    13530254

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN
```

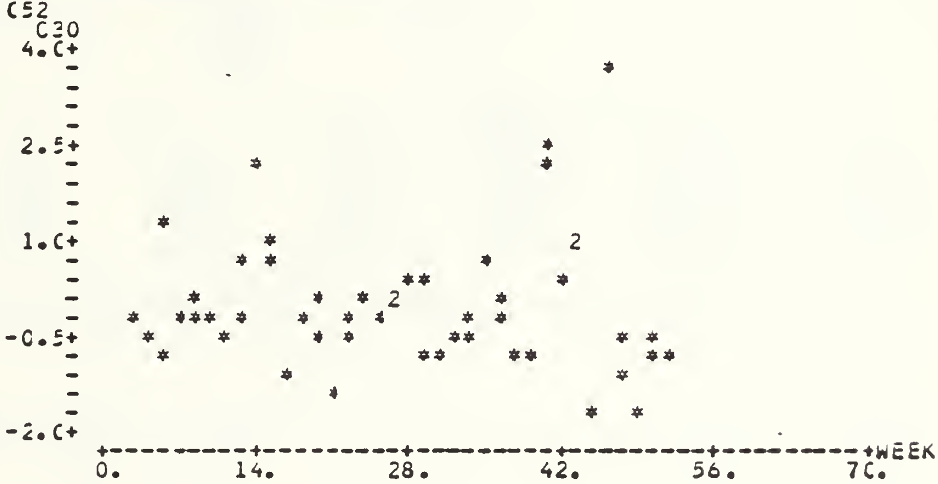
```
 DUE TO       DF          SS
REGRESSION    4      6365793
LAG 1         1      5578141
PRE EX        1       130978
ON EX         1       472337
LAG 2         1       184336

                X1          Y        PRED. Y     ST.DEV.
ROW        LAG 1     COST/DAY       VALUE      PRED. Y      RESIDUAL        ST.RES.
 14          823       1572.9       737.8        98.0         835.1          2.16R
 40          490       1629.6       767.6       107.3         862.0          2.24R
 41         1630       2089.4      1216.9       172.6         872.5          2.43R
 46          629       2318.5      1035.7       189.0        1282.9          3.65RX
 47         2319       1532.9      1853.2       257.5        -320.4         -1.05 X
 48         1533       1532.9      1655.7       217.5        -122.8         -0.37 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.88
```

```
RESIDUALS FROM SELECTED VARIABLE REGRESSION
PLOT C30 VS C52
```



```
   2 MISSING OBSERVATIONS

ADDITION OF FOURTH QUARTER EFFECT
REGRESS C1 ON 5 PRED C2 C10 C4 C5 C9 RESID IN C32

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      294. + 0.464 X1 +0.0281 X2
    -    86.0 X3 +  213. X4 +  351. X5

                                            ST. DEV.     T-RATIO =
         COLUMN       COEFFICIENT           OF COEF.     COEF/S.D.
         --                 293.8             146.4          2.01
X1       LAG 1             0.4636            0.1486          3.12
X2       LAG 2             0.0281            0.1474          0.19
X3       FCST EX            -86.0             121.5         -0.71
X4       ON EX              212.7             117.2          1.82
X5       FOURTH             350.9             175.2          2.00
```

```
THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 390.7
WITH (  50- 6) =  44 DEGREES OF FREEDOM

R-SQUARED = 50.4 PERCENT
R-SQUARED = 44.7 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF           SS       MS=SS/DF
REGRESSION      5      6813114       1362623
RESIDUAL       44      6717126        152662
TOTAL          49     13530254

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

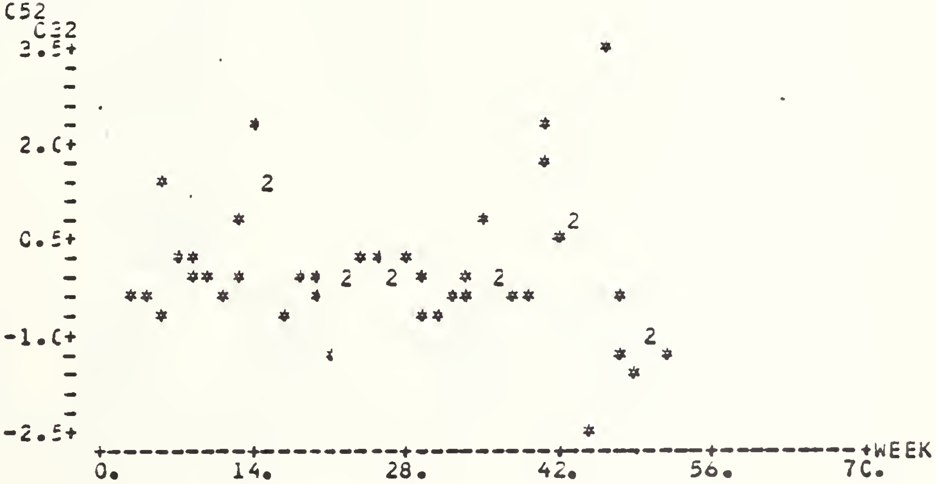
 DUE TO        DF           SS
REGRESSION      5      6813114
LAG 1           1      5578141
LAG 2           1       103242
POST EX         1         2525
ON EX           1       516923
FOURTH          1       612289

               X1            Y       PRED. Y     ST.DEV.
ROW         LAG 1     COST/DAY        VALUE     PRED. Y      RESIDUAL       ST.RES.
 14           823       1572.9        687.3       102.2         885.6         2.35R
 41          1630       2089.4       1327.8       190.7         761.6         2.23R
 45          1709        628.8       1484.8       142.7        -856.0        -2.35R
 46           629       2318.5       1196.8       215.7        1121.7         3.44RX
 47          2319       1532.9       1949.8       261.7        -417.0        -1.44 X
 48          1533       1532.9       1633.1       202.8        -100.2        -0.30 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.82
```

```
RESIDUALS AFTER MODIFICATION
PLOT C32 VS C52
```



```
2 MISSING OBSERVATIONS
```

```
REMOVAL OF LAG 2 EFFECT
REGRESS C1 ON 4 PRED C2 C4 C5 C9 RESID IN C33

THE REGRESSION EQUATION IS
Y =     265. + 0.512 X1 -  55.9 X2
     +  170. X3 +  346. X4

                                           ST. DEV.     T-RATIO =
        COLUMN      COEFFICIENT            OF COEF.     COEF/S.D.
        --               264.8               128.5          2.06
X1      LAG 1           0.5116              0.1294          3.95
X2      POST EX          -55.9               116.5         -0.48
X3      ON EX            170.5               112.1          1.52
X4      FOURTH           345.8               162.1          2.13

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 386.7
WITH (  52- 5) =  47 DEGREES OF FREEDOM

R-SQUARED = 50.5 PERCENT
R-SQUARED = 46.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO       DF           SS        MS=SS/DF
REGRESSION     4      7184720        1796178
RESIDUAL      47      7029652         149567
TOTAL         51     14214372

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO       DF           SS
REGRESSION     4      7184720
LAG 1          1      6140213
POST EX        1        12327
CON EX         1       351649
FOURTH         1       680531

               X1          Y     PRED. Y     ST.DEV.
ROW         LAG 1   COST/DAY       VALUE     PRED. Y     RESIDUAL      ST.RES.
 14           823     1572.9       685.9        86.5        887.0        2.35R
 45          1709      628.8      1484.9       140.2       -856.1       -2.38R
 46           629     2318.5      1102.9       183.5       1215.7        3.57RX
 47          2319     1532.9      1967.4       192.9       -434.5       -1.30 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.87
```

```
FILE: IIIALL   SCRIPT   A   NAVAL POSTGRADUATE SCHOOL



RESIDUALS AFTER MODIFICATION
PLOT C33 VS C52
              C33
             3.5+                                  *
                -
                -
                -
                -           *
             2.0+                               2
                -
                -     *      *
                -            *
                -          *               *     2
             0.5+
                -      **      **  *  *     2   *
                -       ** *      2 *2 *  *         *
                -    **    *     *      ****   *
                -     *       *              *
            -1.0+  2                                  2
                -                *                  *  *
                -
                -                                    *
                -
            -2.5+                                 *
                  +---------+---------+---------+---------+---------+WEEK
                  0.       14.       28.       42.       56.       70.
```

APPENDIX M

COMPUTER LISTING FOR SECOND BN., SECOND BDE.

```
FILE: II2ALL   SCRIPT   A   NAVAL POSTGRADUATE SCHOOL

RETRIEVE 'BD2BN2'
#REGRESSION ON INITIAL VARIABLES
REGRESS C1 ON 9 PRED C2-C5 C10-C14 RESID C60

   46 CASES USED
    6 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      711. + 0.577 X1 +  51.4 X2
    -   302. X3 -  95.3 X4 +0.0079 X5
    - 0.297 X6 + 0.153 X7 +0.0090 X8
    -0.0563 X 9
                                              ST. DEV.     T-RATIO =
         COLUMN       COEFFICIENT             OF COEF.     COEF/S.D.
         --                710.8                 212.7          3.34
X1       LAG 1            0.5770                0.1647          3.50
X2       PRE EX             51.4                 145.0          0.35
X3       POST EX          -302.3                 151.3         -2.00
X4       ON EX             -95.3                 156.6         -0.61
X5       LAG 2            0.0079                0.1900          0.04
X6       LAG 3           -0.2966                0.1871         -1.58
X7       LAG 4            0.1527                0.1863          0.82
X8       LAG 5            0.0090                0.1903          0.05
X9       LAG 6           -0.0563                0.1548         -0.36

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 439.5
WITH (  46-10) =  36 DEGREES OF FREEDOM

R-SQUARED = 48.1 PERCENT
R-SQUARED = 35.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF          SS        MS=SS/DF
REGRESSION      9     6451827          716870
RESIDUAL       36     6954639          193184
TOTAL          45    13406467

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

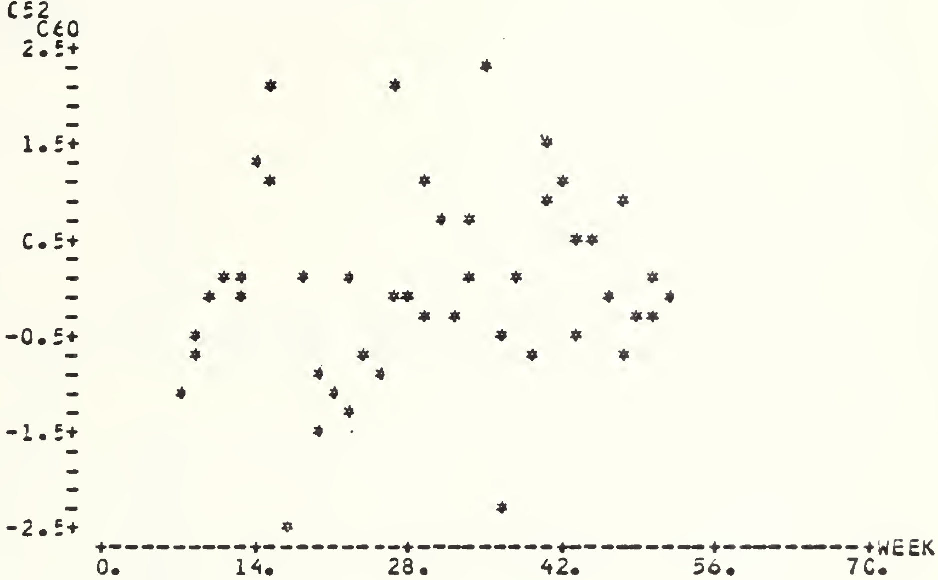
 DUE TO        DF          SS
REGRESSION      9     6451827
LAG 1           1     4754534
PRE EX          1       22878
POST EX         1      962774
ON EX           1       86687
LAG 2           1      129260
LAG 3           1      323377
LAG 4           1      138252
LAG 5           1        8517
LAG 6           1       25551

            X1          Y       PRED. Y    ST.DEV.
ROW      LAG 1   COST/DAY       VALUE    PRED. Y     RESIDUAL      ST.RES.
 15       1757     2374.6      1524.4      159.1        850.2        2.08R
 17       2375      808.7      1765.0      218.8       -956.3       -2.51R
 26         70     1621.9       837.5      222.6        784.4        2.07R
 35        824     2069.6      1143.8      164.4        925.8        2.27R
 36       2070      933.8      1815.1      209.8       -881.2       -2.28R

R DENOTES AN OBS. WITH A LARGE ST. RES.

DURBIN-WATSON STATISTIC = 1.68
```

```
RESIDUALS FROM ALL VARIABLES REGRESSION
PLOT C60 VS C52
```



```
   6 MISSING OBSERVATIONS

STEPWISE REGRESSION
STEPWISE REGRESS C1 ON C2-C5 C10-C14
STEPWISE REGRESSION OFCOST/DAY ON  9 PREDICTORS, WITH N =    46
N(CASES WITH MISSING OBS.) =    6   N(ALL CASES) =    52

      STEP          1         2
CONSTANT        370.3     558.6

LAG 1            0.60      0.50
T-RATIO          4.92      4.06

POST EX                    -326
T-RATIO                   -2.34

S                 443       422
R-SQ            35.46     42.77
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C10.

      STEP          3
CONSTANT        604.9

LAG 1            0.58
T-RATIO          3.81

POST EX          -317
T-RATIO         -2.26

LAG 2           -0.13
T-RATIO         -0.90
```

```
S                423
R-SQ           43.65
MORE? (YES, NO, SUBCOMMAND, CR HELP)
   --
FORCE C5.

    STEP           4
CONSTANT       620.7

LAG 1           0.58
T-RATIO         3.79

POST EX         -325
T-RATIO        -2.30

LAG 2          -0.12
T-RATIO        -0.83

CN EX            -92
T-RATIO        -0.63

S                426
R-SQ           44.35
MORE? (YES, NO, SUBCOMMAND, CR HELP)
   --
FORCE C3.

    STEP           5
CONSTANT       617.3

LAG 1           0.58
T-RATIO         3.69

POST EX         -323
T-RATIO        -2.25

LAG 2          -0.12
T-RATIO        -0.83

CN EX            -87
T-RATIO        -0.58

PRE EX            24
T-RATIO         0.17

S                432
R-SQ           44.43
MORE? (YES, NO, SUBCOMMAND, CR HELP)
REMOVE C4.

    STEP           6          7
CONSTANT       433.6      617.3

LAG 1           0.68       0.58
T-RATIO         4.37       3.69

POST EX                    -323
T-RATIO                   -2.25

LAG 2          -0.16      -0.12
T-RATIO        -1.00      -0.83

CN EX            -49        -87
T-RATIO        -0.32      -0.58

PRE EX            54         24
T-RATIO         0.37       0.17

S                452        432
R-SQ           37.42      44.43
MORE? (YES, NO, SUBCOMMAND, CR HELP)
   --
```

```
REMOVE C3.

    STEP          8
CONSTANT      620.7

LAG 1          0.58
T-RATIO        3.79

POST EX        -325
T-RATIO       -2.30

LAG 2         -0.12
T-RATIO       -0.83

ON EX           -92
T-RATIO       -0.63

PRE EX
T-RATIO

S               426
R-SQ          44.39
MORE? (YES, NO, SUBCOMMAND, OR HELP)
 --
N


REGRESSION ON SELECTED VAARIABLES
REGRESS C1 ON 2 PRED C2 C4 RESID C30

THE REGRESSION EQUATION IS
Y =     405. + 0.636 X1 -  224. X2

                                                ST. DEV.    T-RATIO =
           COLUMN      COEFFICIENT              OF COEF.    COEF/S.D.
           --               405.3                 119.9          3.38
X1         LAG 1           0.6357                0.1013          6.28
X2         POST EX         -223.7                 127.8         -1.75

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 418.9
WITH (   52-  3) =  49 DEGREES OF FREEDOM

R-SQUARED = 49.3 PERCENT
R-SQUARED = 47.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO         DF            SS        MS=SS/DF
REGRESSION       2       8365284         4182643
RESIDUAL        49       8596384          175436
TOTAL           51      16961669

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO         DF            SS
REGRESSION       2       8365284
LAG 1            1       7827317
POST EX          1        537965

               X1           Y     PRED. Y     ST.DEV.
ROW         LAG 1    COST/DAY      VALUE     PRED. Y     RESIDUAL       ST.RES.
 15          1757      2374.6      1522.5       106.5        852.1         2.10R
 16          2375      2374.6      1914.9       159.1        459.7         1.19 X
 17          2375       808.7      1914.9       159.1      -1106.2        -2.86RX
 26            70      1621.9       450.0       114.2       1171.9         2.91R
 35           824      2069.6       929.3        71.2       1140.4         2.76R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.
```

```
DURBIN-WATSON STATISTIC = 1.84


RESIDUALS FROM SELECTED VARIABLE REGRESSION
PLOT C30 VS C52
      C30
     3.0+                   *
        -                         *
        -
        -           *
        -
     1.5+
        -          **                 *
        -                             **
        -                   *    *       *  *
        -    *  ***      *   *  *        *
     0.0+      *  *            *  *        *  2*
        -    ***      **  **        ***      *
        -                    * *
        -  2**           *               *
        -                *                 *
    -1.5+              *
        -
        -                          *
        -
        -
    -3.0+            *
          +---------+---------+---------+---------+---------+WEEK
          0.       14.       28.       42.       56.       70.


ADDITION OF SECOND QUARTER EFFECT
REGRESS C1 ON 3 PRED C2 C4 C7 RESID IN C32

THE REGRESSION EQUATION IS
Y =       402. + 0.636 X1 -   224. X2
    +     13.0 X3

                                          ST. DEV.     T-RATIO =
       COLUMN      COEFFICIENT            OF COEF.     COEF/S.D.
       --                401.8              126.4          3.18
X1     LAG 1            0.6360             0.1023          6.21
X2     POST EX          -223.7              129.1         -1.73
X3     SECOND             13.0              135.5          0.10

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 423.2
WITH (   52- 4) =   48 DEGREES OF FREEDOM

R-SQUARED = 49.3 PERCENT
R-SQUARED = 46.2 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF            SS          MS=SS/DF
REGRESSION      3       8366930           2788975
RESIDUAL       48       8594727            179057
TOTAL          51      16961669

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF            SS
REGRESSION      3       8366930
LAG 1           1       7827317
POST EX         1        537965
SECOND          1          1647
```

```
                 X1               Y        PRED. Y      ST.DEV.
ROW           LAG 1        COST/DAY          VALUE      PRED. Y       RESIDUAL       ST.RES.
 15            1757          2374.6         1532.5        149.3          842.1         2.13R
 16            2375          2374.6         1925.0        191.9          449.6         1.19 X
 17            2375           808.7         1925.0        191.9        -1116.3        -2.96RX
 26              70          1621.9          459.5        152.5         1162.4         2.94R
 35             824          2069.6          926.0         79.7         1143.6         2.75R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.84


RESIDUALS OF MODIFIED REGRESSION
PLOT C32 VS C52
              C32
             3.0+                    *
                -                          *
                -
                -            *
                -
             1.5+
                -           **                 *
                -                              **
                -                    *  *  *       *  *
                -     *  ***      *   *          *
             0.0+       *  *           *  * *      *  2*
                -     ***      **  **        **      *
                -                      * *
                -  2**           *               *
                -                 *                 *
            -1.5+               *
                -
                -                          *
                -
                -
            -3.0+             *
                  +---------+---------+---------+---------+---------+WEEK
                  0.       14.       28.       42.       56.       70.

REMOVAL OF SECOND QUARTER EFFECT
REGRESS C1 ON 2 PRED C2 C4 RESID C33

THE REGRESSION EQUATION IS
Y =     405. + 0.636 X1 -  224. X2

                                            ST. DEV.      T-RATIO =
       COLUMN       COEFFICIENT             OF COEF.      COEF/S.D.
       --                405.3                 119.9           3.38
X1     LAG 1            0.6357                0.1013           6.28
X2     POST EX          -223.7                 127.8          -1.75

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 418.9
WITH (   52-  3) =  49 DEGREES OF FREEDOM

R-SQUARED = 49.3 PERCENT
R-SQUARED = 47.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO         DF              SS        MS=SS/DF
REGRESSION       2         8365284         4182643
RESIDUAL        49         8596384          175436
TOTAL           51        16961669

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN
```

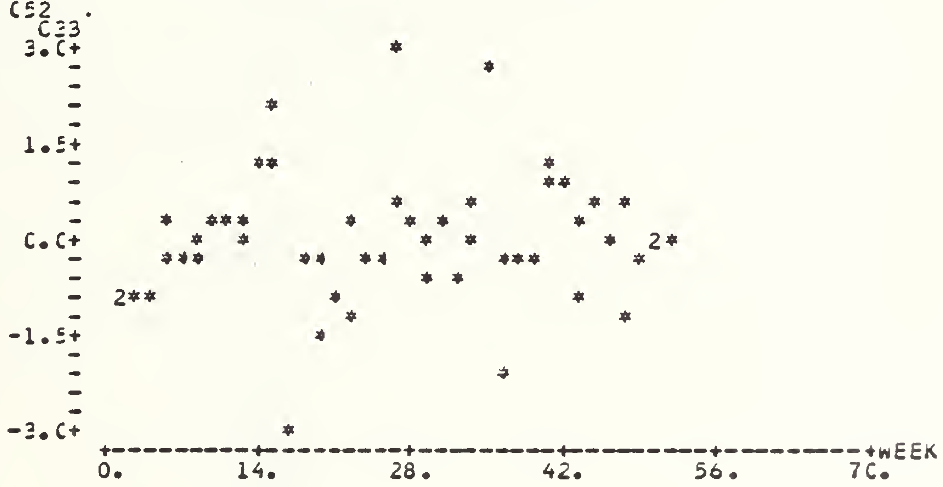
```
 DUE TO       DF            SS
REGRESSION     2       8365284
LAG 1          1       7827317
POST EX        1        537965

             X1           Y        PRED. Y      ST.DEV.
ROW       LAG 1    COST/DAY        VALUE      PRED. Y     RESIDUAL       ST.RES.
 15        1757      2374.6       1522.5        106.5        852.1          2.10R
 16        2375      2374.6       1914.9        159.1        459.7          1.19 X
 17        2375       808.7       1914.9        159.1      -1106.2         -2.86RX
 26          70      1621.9        450.0        114.2       1171.9          2.91R
 35         824      2069.6        929.3         71.2       1140.4          2.76R

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.84


RESIDUAL PLOT AFTER REMOVAL OF SECOND QUARTER EFFECT
PLOT C33 VS C52
```



APPENDIX N

COMPUTER LISTING FOR THIRD BN., SECOND BDE.

```
FILE: II3ALL   SCRIPT   A   NAVAL POSTGRADUATE SCHOOL

RETRIEVE 'BC2BN3'
REGRESSION ON INITIAL VARIABLES
REGRESS C1 ON 9 PRED C2-C5 C10-C14 RESID C60

   46 CASES USED
    6 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =      401. + 0.987 X1 +  5.03 X2
    +  241. X3 +  151. X4 - 0.591 X5
    + 0.233 X6 - 0.171 X7 + 0.149 X8
    - 0.108 X 9

                                            ST. DEV.      T-RATIO =
       COLUMN       COEFFICIENT             OF COEF.      COEF/S.D.
       --                 401.2               242.9          1.65
X1     LAG 1             0.9865              0.1653          5.97
X2     PRE EX               5.0               229.8          0.02
X3     POST EX            240.6               279.1          0.86
X4     ON EX              150.8               282.6          0.53
X5     LAG 2            -0.5910              0.2558         -2.31
X6     LAG 3             0.2329              0.2435          0.96
X7     LAG 4            -0.1713              0.2570         -0.67
X8     LAG 5             0.1487              0.2510          0.59
X9     LAG 6            -0.1082              0.2032         -0.53

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 641.1
WITH (  46-10) =  36 DEGREES OF FREEDOM

R-SQUARED = 57.7 PERCENT
R-SQUARED = 47.1 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF           SS          MS=SS/DF
REGRESSION      9      20160417          2240045
RESIDUAL       36      14798345           411065
TOTAL          45      34958744

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF           SS
REGRESSION      9      20160417
LAG 1           1      17192945
PRE EX          1            55
POST EX         1         26138
ON EX           1         24372
LAG 2           1       2457766
LAG 3           1        205793
LAG 4           1         90145
LAG 5           1         46740
LAG 6           1        116504

              X1            Y      PRED. Y     ST.DEV.
ROW        LAG 1     COST/DAY       VALUE     PRED. Y     RESIDUAL       ST.RES.
 22         1986       -348.9      1546.5       225.8      -1895.4       -3.16R
 26          -28         53.4       576.1       432.8       -522.7       -1.10 X
 27           53        126.0       213.8       445.7        -87.8       -0.19 X
 47         1836       3826.8      1634.7       283.3       2192.1        3.81R
 48         3827       3826.8      3489.5       451.3        337.3        0.74 X
 49         3827       1778.1      2491.5       424.7       -713.4       -1.49 X
 50         1778        954.5      1021.0       442.4        -66.5       -0.14 X
 51          954        849.7       629.7       429.7        220.0        0.46 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 2.01
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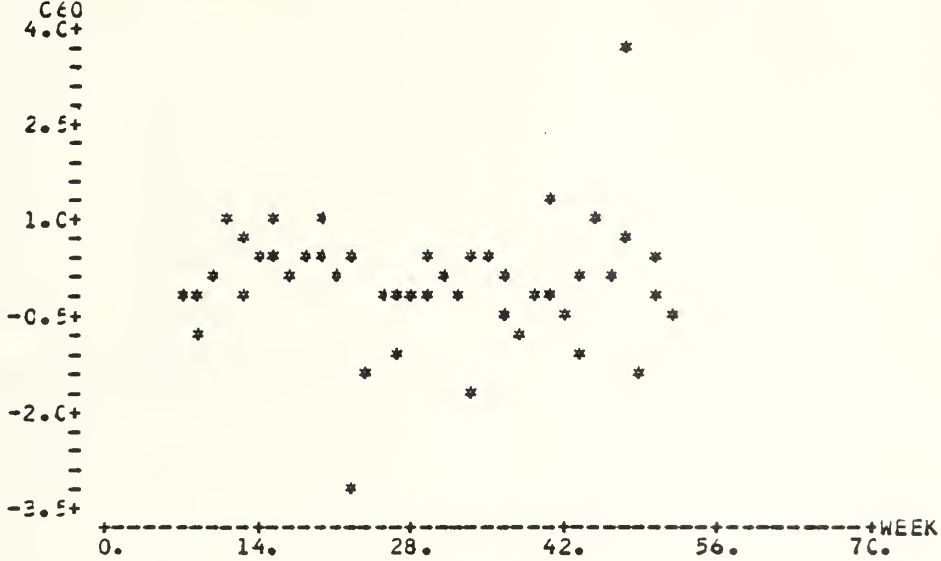
RESIDUALS FROM INITIAL REGRESSION
PLOT C60 VS C52
```



```
   6 MISSING OBSERVATIONS

STEPWISE RECRESSION
STEPWISE REGRESS C1 ON C2-C5 C10-C14
STEPWISE REGRESSION OFCOST/DAY ON  9 PREDICTORS, WITH N =    46
N(CASES WITH MISSING OBS.) =    6   N(ALL CASES) =    52

    STEP          1         2
CONSTANT      299.2     405.5

LAG 1          0.70      0.95
T-RATIO        6.53      6.63

LAG 2                   -0.35
T-RATIO                 -2.46

S               635       602
R-SQ          49.18     55.46
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C5.

    STEP          3
CONSTANT      400.4

LAG 1          0.95
T-RATIO        6.56

LAG 2         -0.36
T-RATIO       -2.45

CN EX            65
T-RATIO        0.29

S               608
R-SQ          55.54
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C3.
```

```
     STEP         4
CONSTANT      409.9

LAG 1          0.95
T-RATIO        6.47

LAG 2         -0.36
T-RATIO       -2.42

CN EX            55
T-RATIO        0.23

PRE EX          -22
T-RATIO       -0.11

S               616
R-SQ          55.56
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
REMOVE C3.

     STEP         5
CONSTANT      400.4

LAG 1          0.95
T-RATIO        6.56

LAG 2         -0.36
T-RATIO       -2.45

CN EX            65
T-RATIO        0.29

PRE EX
T-RATIO

S               608
R-SQ          55.54
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
FORCE C4.

     STEP         6
CONSTANT      398.2

LAG 1          0.93
T-RATIO        6.35

LAG 2         -0.42
T-RATIO       -2.57

CN EX           147
T-RATIO        0.60

PRE EX
T-RATIO

POST EX         219
T-RATIO        0.87

S               610
R-SQ          56.36
MORE? (YES, NO, SUBCOMMAND, OR HELP)
--
REMOVE C5.

     STEP         7
CONSTANT      408.7

LAG 1          0.93
T-RATIO        6.44
```

```
FILE: II3ALL    SCRIPT    A    NAVAL POSTGRADUATE SCHOOL


LAG 2          -0.39
T-RATIO        -2.53

ON EX
T-RATIO

PRE EX
T-RATIO

POST EX          161
T-RATIO         0.70

S                605
R-SQ           55.97
MORE? (YES, NO, SUBCOMMAND, OR HELP)
   --
N
REGRESSION ON SELECTED VARIABLES
REGRESS C1 ON 2 PRED C2 C10 RESID IN C30

   50 CASES USED
    2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     395. + 0.947 X1 - 0.336 X2

                                                ST. DEV.     T-RATIO =
        COLUMN      COEFFICIENT                 OF COEF.     COEF/S.D.
        --                394.9                   130.6           3.02
X1      LAG 1            0.9467                  0.1372           6.90
X2      LAG 2           -0.3359                  0.1355          -2.48

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 580.3
WITH (   50- 3) =  47 DEGREES OF FREEDOM

R-SQUARED = 56.2 PERCENT
R-SQUARED = 54.3 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF            SS          MS=SS/DF
REGRESSION      2      20284738          10142364
RESIDUAL       47      15829210            336791
TOTAL          49      36113929

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

 DUE TO        DF            SS
REGRESSION      2      20284738
LAG 1           1      18214588
LAG 2           1       2070155

              X1           Y      PRED. Y      ST.DEV.
ROW        LAG 1    COST/DAY        VALUE      PRED. Y      RESIDUAL        ST.RES.
 22         1986      -348.9       1608.0        130.8       -1956.9         -3.46R
 23         -349      -348.9       -602.5        309.2         253.7          0.52 X
 47         1836      3826.8       1601.8        114.5        2225.0          3.91R
 48         3827      3826.8       3400.9        325.9         425.9          0.89 X
 49         3827      1778.1       2732.2        301.6        -954.1         -1.92 X
 50         1778       954.5        792.7        327.9         161.8          0.34 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.92
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RESIDUALS OF SELECTED REGRESSION
PLOT C30 VS C52
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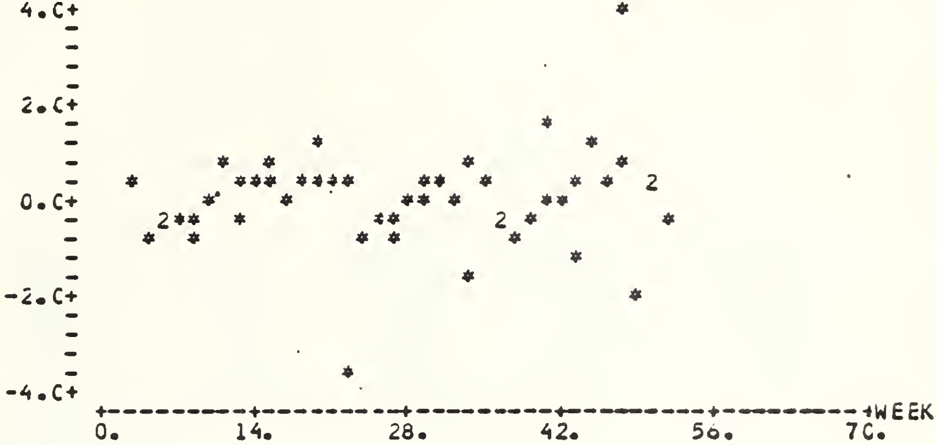

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   2 MISSING OBSERVATIONS

REGRESSION WITH ADDITION OF FOURTH QUARTER EFFECT
REGRESS C1 ON 3 PRED C2 C9 C10 RESID C32

    50 CASES USED
     2 CASES CONTAINED MISSING VALUES

THE REGRESSION EQUATION IS
Y =     384. + 0.897 X1 +  372. X2
    - 0.373 X3

                                               ST. DEV.      T-RATIO =
         COLUMN       COEFFICIENT              OF COEF.      COEF/S.D.
         --                 384.2                127.5           3.01
X1       LAG 1             0.8967               0.1366           6.57
X2       FOURTH             372.3                201.7           1.85
X3       LAG 2            -0.3726               0.1336          -2.79

THE ST. DEV. OF Y ABOUT REGRESSION LINE IS
S = 566.0
WITH (  50-  4) =  46 DEGREES OF FREEDOM

R-SQUARED = 59.2 PERCENT
R-SQUARED = 56.5 PERCENT, ADJUSTED FOR D.F.

ANALYSIS OF VARIANCE

 DUE TO        DF            SS        MS=SS/DF
REGRESSION      3      21376333         7125442
RESIDUAL       46      14737577          320382
TOTAL          49      36113910

FURTHER ANALYSIS OF VARIANCE
SS EXPLAINED BY EACH VARIABLE WHEN ENTERED IN THE ORDER GIVEN

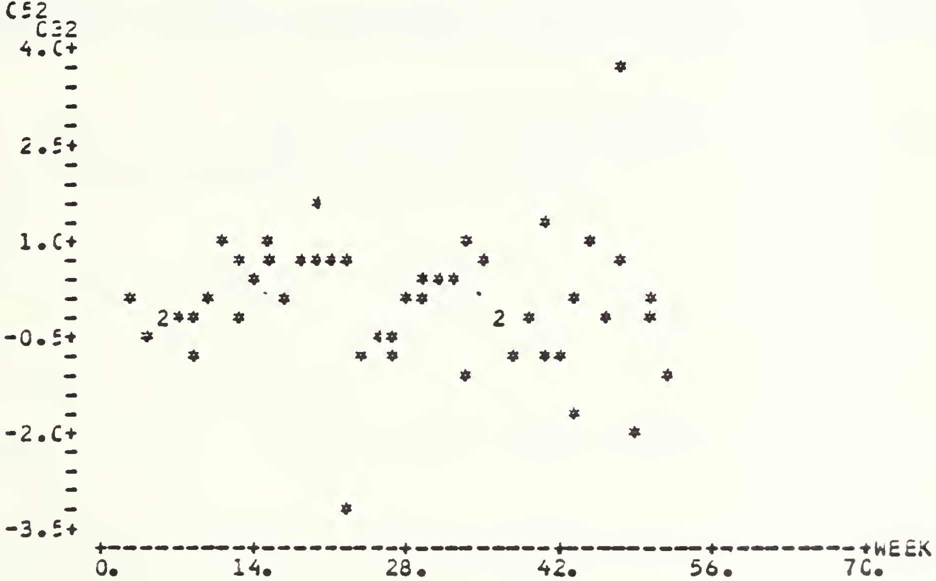
 DUE TO        DF            SS
REGRESSION      3      21376333
LAG 1           1      18214568
FOURTH          1        670764
LAG 2           1       2491003
```

```
FILE: II3ALL    SCRIPT    A    NAVAL POSTGRADUATE SCHOOL


              X1            Y     PRED. Y     ST.DEV.
ROW       LAG 1      COST/DAY       VALUE     PRED. Y     RESIDUAL        ST.RES.
 22        1988        -348.9      1425.1       161.5      -1774.0         -3.27R
 23        -349        -348.9      -668.8       303.7        319.9          0.67 X
 47        1838        3826.8      1813.6       160.1       2013.2          3.71R
 48        3827        3826.8      3503.9       322.7        322.9          0.69 X
 49        3827        1778.1      2762.1       294.6       -984.0         -2.04RX
 50        1778         954.5       924.9       327.7         29.6          0.06 X

R DENOTES AN OBS. WITH A LARGE ST. RES.
X DENOTES AN OBS. WHOSE X VALUE GIVES IT LARGE INFLUENCE.

DURBIN-WATSON STATISTIC = 1.96
RESIDUALS AFTER MODIFICATION
PLOT C32 VS C52
```



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  2 MISSING OBSERVATIONS
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